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# STANDARD SPECIFICATIONS 1965



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# STANDARD SPECIFICATIONS

## 1965

528

STREETS, HIGHWAYS, SEWERAGE,  
STRUCTURES, AND OTHER PUBLIC WORKS

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## PART I

### GENERAL BIDDING AND CONTRACTUAL PROVISIONS

#### Section 100

#### Definitions and Terms

Whenever, in these Standard Specifications or in other contract documents, the following abbreviations and terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows:

#### ABBREVIATIONS

AASHO	American Association of State Highway Officials.
AISC	American Institute of Steel Construction.
AREA	American Railway Engineering Association.
ASA	American Standards Association.
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers.
ASME	American Society of Mechanical Engineers.
ASTM	American Society for Testing and Materials.
AWG	American Wire Gage.
AWS	American Welding Society
AWSS	Auxiliary Water Supply System.
AWWA	American Water Works Association
EIA	Electronic Industries Association.
IEEE	Institute of Electrical and Electronic Engineers.
ITE	Institute of Traffic Engineers.
NBFU	National Board of Fire Underwriters.
NEC	National Electrical Code.
NEMA	National Electrical Manufacturers Association.
SAE	Society of Automotive Engineers
SMACNA	Sheet Metal and Air Conditioning Contractors' Na- tional Association, Inc.
SSPC	Steel Structures Painting Council.
UL	Underwriters' Laboratories, Inc.

All references to specifications of the above listed agencies or codes are understood to refer to the current specifications as revised or amended at the date of receipt of bids.

APPROVED; DIRECTED; PERMITTED; REQUIRED.--The approval, direction, permission or requirement of the Director.

ACCEPTABLE; SATISFACTORY; NECESSARY.--Acceptable to, satisfactory to, or necessary in the judgement of the Director.

BID.--Same as Proposal. The written offer of a Bidder to perform the specified work, when made out and submitted on a proposal form furnished by the City.

BIDDER.--Any individual, firm, partnership, corporation, or combination thereof, acting directly or through a duly authorized representative, submitting a proposal for the work contemplated.

CHARTER.--The Charter of the City and County of San Francisco as adopted March 26, 1931 (in effect January 8, 1932), including subsequent revisions and amendments thereto.

CITY.--The City and County of San Francisco, State of California.

CITY ENGINEER or ENGINEER.--The City Engineer of the City and County of San Francisco, State of California, acting directly or through properly authorized agents limited by the particular duties entrusted to them.

CONTRACT.--The written agreement covering the performance of the work. The Contract includes the advertisement calling for bids, the proposal, plans, specifications, contract bonds, and all supplemental agreements affecting the work.

CONTRACT COST.--The aggregate amount or price promised to be paid by the City to the Contractor upon fulfillment of the contract, or such aggregate amount adjusted as provided in Section 111 herein. The aggregate amount is the lump sum or total of lump sums bid in the Proposal, or is the sum of the products of the number of units of work in each class, as shown in the Proposal, multiplied by the respective unit prices bid in the Proposal.

CONTRACTOR.--The person or persons, firm, co-partnership, corporation, or combination thereof, or his, their or its duly authorized representative, who, as party or parties of the first part, has or have entered into a contract with the City to do the work contemplated.

DATE OF ACCEPTANCE.--The date set forth in the Order of the Department of Public Works accepting the work.

DAY.--Calendar day, any and every day shown on the calendar, Sundays and holidays included, unless otherwise designated.

DEPARTMENT OF PUBLIC WORKS or DEPARTMENT.--The Department of Public Works of the City and County of San Francisco, State of California.

DIRECTOR OF PUBLIC WORKS or DIRECTOR.--The Director of the Department of Public Works acting directly or through properly authorized agents limited by the particular duties entrusted to them.

PLANS.--The drawings, or reproductions thereof, approved by the Engineer, pertaining to the work and made a part of the contract.

PROPOSAL.--Same as Bid. The written offer of a Bidder to perform the specified work, when made out and submitted on a proposal form furnished by the City.

SECTION.--The numbered and decimally numbered sections into which the material in these Standard Specifications is divided. Reference to a section shall include reference to all decimally numbered sections thereunder.

SPECIAL PROVISIONS.--Written directions, terms, provisions and requirements peculiar to the work and supplementary to these Standard Specifications.

SPECIFICATIONS.--The information, directions, provisions and requirements pertaining to the work, and contained in these Standard

Specifications, in the Special Provisions, and in all supplemental contract documents. Plans shall also be considered to be a part of the specifications wherever, in any of the contract documents, the word "specifications" is used without any simultaneous reference to the plans.

**WORK.**—The improvement, structure, project, or construction, or any part thereof, contemplated in the contract; the furnishing of necessary labor, materials, equipment, tools and other devices, and the doing or performing by the Contractor of any or all things required to be done for the fulfillment of the contract as provided therein.

## Section 101

### Instructions and Information for Bidders

**101.01 QUALIFICATIONS OF BIDDERS.**—Each Bidder and each Subcontractor shall possess a current, valid and appropriate Contractors' State License. Attention is directed to the provisions of Chapter 9 of Division 3 of the State of California Business and Professions Code concerning the licensing of contractors.

In accordance with the provisions of Section 200, Part III of the San Francisco Municipal Code, the successful Bidder must possess a City of San Francisco Contractor's License which can be obtained at the office of Tax Collector, Room 107, City Hall, upon the payment of the \$10.00 license tax required therefor.

Each Bidder shall insert the number of his State Contractors' License and the number of his City Contractor's License in the spaces provided on the Proposal form. If the successful Bidder fails to list the license numbers, he shall, when required, furnish proof of possession thereof before the contract is awarded.

In accordance with the provisions of Sections 6.23, 6.46 and 6.47 of the San Francisco Administrative Code, each Bidder, and each Subcontractor listed in his Proposal, shall furnish to the Director information concerning his experience and financial qualifications. Instructions relative to the fulfillment of these requirements may be obtained at the Department of Public Works, Room 260, City Hall.

**101.02 DEPOSIT AND PAYMENT FOR SPECIFICATIONS.**—Special Provisions and plans can be obtained at the Bureau of Engineering, Room 351, City Hall, on payment of the deposit specified in the advertisement inviting Proposals.

Unless otherwise stated in the advertisement, the deposit for the Special Provisions and plans will be refunded upon their return in good condition within thirty (30) calendar days after the receipt of bids, and if not so returned, such Special Provisions and plans will become the property of the depositor and no refund will be made.

Standard Specifications can be obtained at the Purchasing Department, City Hall, on receipt of the prescribed payment therefor.

101.03 PROPOSAL; SUBMISSION AND RECEIPT OF BIDS.--Each Bidder shall use only the official forms included in the Proposal, shall make out such forms in full, and shall make all entries thereon, including the entries on the Schedule of Bid Prices, in ink or by typewriter.

The completed Proposal, properly signed and attested, and accompanied by the required certified check or corporate surety bid bond and the list of subcontractors, stapled together in the same order as when originally received, shall be enclosed in a sealed envelope addressed to the Director of Public Works, and shall be submitted in the manner, and at the place and time set forth in the advertisement. The envelope shall be endorsed with the superscription indicated on the lower part of the cover of the Special Provisions.

Unless otherwise specified, Bidders shall bid on all Bid Items included in the Proposal. In determining the low Bidder, only the total of all Bid Items will be considered. No award will be made on individual Bid Items.

In case of a discrepancy between unit bid prices and extensions thereof, the unit bid prices shall prevail.

In case of a discrepancy between the sum of the correct extensions and the total, the sum of the correct extensions shall prevail.

No person, corporation or firm will be allowed to make, file, or be interested as a principal in, more than one Proposal or bid for the work, and each Bidder must execute the affidavit on the Proposal.

Any statement accompanying and tending to qualify a bid shall cause rejection of such bid, unless such statement is required in a Proposal embracing alternative bids.

When, in the opinion of the Director of Public Works, the prices in any Proposal are obviously unbalanced, such Proposal shall be rejected.

Bids received from Bidders to whom specifications and plans have not been officially issued will be rejected.

All bids received as herein provided will be opened and publicly read by the Director upon the expiration of the period named in the advertisement. After tabulation, Bidders may inspect the bids.

The Director of Public Works reserves the right to waive technical defects in bidding.

101.04 CERTIFIED CHECK OR CORPORATE SURETY BOND TO ACCOMPANY PROPOSAL.--Each Proposal must be accompanied by a certified check or corporate surety bond for an amount equal to not less than 10 percent of the total amount of the bid. The certified check must be drawn on a solvent bank in the State of California, payable on sight to the City and County of San Francisco. When award of contract is made, all checks or bonds will be returned except the retained check or bond of the successful Bidder, which will be returned upon execution of the contract and filing of the required performance bond and labor and material bond.

When the work proposed to be done under the contract is subdivided into more than one proposition and the form of Proposal affords the Bidder the opportunity to bid on an optional amount of the total work,

the certified check or corporate surety bond specified above shall be for an amount not less than 10 percent of the total price of the maximum amount of work that can be awarded to the Bidder in accordance with the bid prices contained in his Proposal.

#### 101.05 LIST OF SUBCONTRACTORS TO ACCOMPANY PROPOSAL.

--Each Bidder, on the blank form provided for this purpose with his Proposal, shall set forth, for each Subcontractor who will perform any portion of the work in excess of one-half (1/2) of one percent (1%) of the General Contractor's total bid, the following information:

- 1) Name of Subcontractor.
- 2) Address of Subcontractor.
- 3) Brief description of work to be performed under subcontract.
- 4) Amount to be paid for Subcontractor's work, labor or service.

101.06 ESTIMATE OF THE AMOUNT OF WORK TO BE DONE.--The amount of work included in a lump sum bid is set forth in the specifications and shown on the plans. The amount of each class of work included in a unit price bid will have been preliminarily estimated, as shown on the schedule of bid prices in the Proposal, and this estimate will be used as a basis for comparing bids. The Director does not expressly, or by implication, agree that the actual amount of work will correspond with the amount so shown or estimated, but reserves the right to increase or decrease the amount of any class or portion of the work, to leave out an entire Bid Item or Items, or to add work of a class not included in the Proposal, when in his judgment such change is best in the interest of the City. No such change in the work shall be considered as a waiver of any other condition of the contract.

The adjustment in compensation for any increase or decrease in the amount of work shall be in accordance with the applicable provisions of Sections 101.07 and 111.

101.07 DECREASE OF MORE THAN 25 PERCENT IN SCHEDULE OF BID PRICE QUANTITY. --Should the pay quantity of actual work required under any Bid Item be, or be reduced to, less than 75 percent of the quantity shown in the Schedule of Bid Prices and the value of the depletion, based on contract bid prices, exceeds Two Thousand Dollars (\$2,000.00), the Contractor may request an increase in the unit price bid for that particular Bid Item.

Such increase in price, adjusted to compensate for fixed costs, will be negotiated in accordance with the procedure set forth in Section 111.

Payment for the total pay quantity for such Bid Item will in no case exceed the payment which would have been made for 75 percent of the quantity set forth in the Schedule of Bid Prices at the original unit price bid therefor.

In the case of piles, where several length categories may be included for furnishing and for driving, only the total length of piles furnished, or total number of piles driven, regardless of category, will be used as a basis in computing a decrease.

No adjustment of the unit price bid will be made in the instance of an increase in the quantity of any Bid Item.

101.08 EXAMINATION OF PLANS, SPECIFICATIONS, PROPOSAL, AND SITE OF WORK. --Bidders shall examine carefully the site of the contemplated work, the plans and specifications, and the Proposal and included forms. The submission of a bid shall be conclusive evidence that the Bidder has investigated and is satisfied as to the conditions to be encountered, as to the character, quality, and scope of work to be performed, as to the quantities of materials to be furnished, and as to the requirements of the Proposal, plans, and specifications.

Bidders must include in their bid prices the entire cost of the work contemplated in the contract, and it is understood and agreed that there is included, in each lump sum or unit price bid, the entire cost of all work incidental to the completion of that portion of the work.

It is understood that information as to underground, or other, conditions or obstructions, indicated on the plans or in the specifications, has been obtained with reasonable care, and has been recorded in good faith. There is no expressed or implied agreement that such information, or the depths, character of materials or water conditions, are correctly shown. Bidders must take into account the possibility that conditions affecting the cost or quantities of work may differ from those indicated, and shall make any additional subsurface investigation they consider necessary.

Records of existing structures in the vicinity of the site of the work may be on file in the City Engineer's Office, and may be examined by the Bidder. The Bidder should note, however, that these structures may differ from the records on file, or may have been altered, and that no representation is made, nor responsibility taken, by the City as to the accuracy of the locations and other data shown on such records.

101.09 ADDITIONAL INFORMATION PRIOR TO RECEIPT OF BIDS. --If the meaning and intent of the specifications is not clear to a Bidder, he shall request clarification or interpretation from the City Engineer at least three (3) working days before the date of receipt of bids. If necessary, a clarifying addendum will be delivered to all parties who obtained specifications, and such addendum will be an incorporated part of the specifications.

The City will not be responsible for oral instructions or information, concerning the specifications or the work, given out by its officers, employees or agents to prospective Bidders.

## Section 102

### Award and Execution of Contract

102.01 AWARD OF CONTRACT. --The Director may reject any and all bids. The award of contract, if made, will be to the lowest reliable and responsible Bidder whose Proposal complies with all the requirements prescribed, and will be made not less than ten (10) days after the last date of publication of the notice inviting sealed bids, or more than twenty (20) days after the receipt of bids, unless the time for letting the contract be extended by resolution of the Board of Supervisors on the recommendation of the Director.

102.02 EXECUTION OF CONTRACT. --The successful Bidder will be allowed a maximum of ten (10) calendar days, after the date on which the contract is awarded, in which to deliver the contract with his signature affixed thereto, together with the corporate surety bonds and insurance documents required by Sections 102.03, 102.04, 102.05, 102.06 and 102.07, to the Director of Public Works.

If the successful Bidder shall for ten (10) days after such award fail or neglect so to enter into the Contract, the Director, in accordance with the provisions of Section 6.20 of the Administrative Code, will deposit the corporate surety bond or certified check which accompanied the Proposal of such Bidder with the Treasurer of the City for collection, and the proceeds thereof shall be retained by the City as liquidated damages for the failure of such Bidder to enter into said contract, unless upon recommendation of the Director together with the approval of the Chief Administrative Officer, the Board of Supervisors, by resolution, approves the return of such check or bond.

102.03 PERFORMANCE BOND TO BE FILED. --Before the execution of the contract, the Bidder to whom the contract is awarded shall file with the Department of Public Works a corporate surety bond, in an amount of not less than 50 percent of the amount of the contract as awarded, as a guarantee of good faith on the part of the said Bidder to execute the work in accordance with the terms of the contract.

102.04 LABOR AND MATERIAL BOND TO BE FILED. --Before the execution of the contract, the Bidder to whom the contract is awarded shall file with the Department of Public Works a corporate surety bond, in an amount of not less than 50 percent of the amount of the contract as awarded, as a guarantee on the part of said Bidder to pay in full all bills and accounts for wages for services engaged, and for materials, supplies and equipment used, in the performance of the work in the contract.

102.05 WORKMEN'S COMPENSATION INSURANCE. --The Contractor shall maintain in full force and effect during the life of the contract a policy of workmen's compensation insurance in accordance with the provisions of Division IV of the California Labor Code.

102.06 PUBLIC LIABILITY AND PROPERTY DAMAGE INSURANCE.

--The Contractor shall maintain in full force and effect during the life of the contract such Public Liability and Property Damage Insurance, including coverage for motor vehicles, as shall protect him and any subcontractor performing work covered by the contract, from claims for damages for bodily injury including wrongful death, as well as from claims for property damages, which may arise because of the nature of the work or from operations under the contract, whether such operations be by himself or by any subcontractor or anyone directly or indirectly employed by either of them even though such damages be not caused by the negligence of the Contractor, or any subcontractor, or anyone employed by either of them. The said Public Liability and Property Damage Insurance shall also directly protect the City and County of San Francisco and any other parties specified in the Special Provisions to be included as co-insureds, as well as the Contractor and his subcontractors, and all insurance policies issued hereunder shall so state. The amounts of such insurance shall be as follows:

Public Liability Insurance in an amount not less than \$100,000 for injuries, including wrongful death, to any one person, and, subject to the same limit for each person, in an amount not less than \$300,000 on account of one accident, and Property Damage Insurance in an amount not less than \$100,000, provided, however, that the Director of Public Works may accept insurance, covering a subcontractor, in character and amounts less than the standard requirements set forth under this paragraph where such standard requirements appear excessive because of the character or extent of the work to be performed by such subcontractor.

102.07 COPIES OF INSURANCE POLICIES AND CERTIFICATES TO BE FILED.--Before execution of the contract, the Bidder to whom the contract is awarded shall file with the Department of Public Works, a certified copy of the policy or policies of the Public Liability and Property Damage insurance and two certificates of insurance for each policy of Public Liability, Property Damage and Workmen's Compensation covering all insurance hereinbefore required. Each such policy and certificate shall provide that no cancellation, or reduction in coverage or any other change, shall become effective until at least ten (10) days after receipt by the Director of Public Works of written notice thereof. If the life of the contract extends beyond the expiration date of any policy so filed, a certified copy of the new or renewed policy and two certificates of insurance for such policy shall be filed with the Department of Public Works at least ten (10) days before such expiration. Failure to maintain, or renew such policies will be sufficient cause for termination of contract.

## Section 103

### Extent of Work

103.01 MEANING AND INTENT OF PLANS AND SPECIFICATIONS. -- These Standard Specifications, the plans, Special Provisions, contract change orders, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be self-explanatory and cooperative, and to describe and provide for a complete work.

Should it appear that the work to be done or any of the matters relative thereto are not sufficiently detailed or explained in the plans or specifications, or should there be any questions which may arise as to the meaning or intent of the plans or specifications, the matter shall be referred to the Engineer, who shall interpret the true meaning and intent of the plans and specifications.

103.02 TITLES, REFERENCES AND DIMENSIONS. -- Titles, headings, subheadings and indexes are used primarily for convenience and are not necessarily deemed to be parts of the contract. The misplacement, addition or omission of any word, letter, figure, or punctuation mark shall in no way lessen or change the intent or meaning of the specifications.

The reprinting or repetition in the specifications of certain clauses from any other specification or law or document, to which reference is made herein, shall in no way limit the scope of such reference or the applicability of any such specification, law or document, in its entirety.

Where work is not dimensioned on plans, it shall be executed according to the scale, but figured dimensions shall govern in all cases, although they may differ from the scale dimensions.

103.03 REASONABLY IMPLIED PARTS OF THE WORK SHALL BE DONE THOUGH ABSENT FROM SPECIFICATIONS. -- Any part of the work which is not mentioned in the specifications but is shown on the plans, or any part not shown on the plans but described in the specifications, or any part not shown on the plans nor described in the specifications, but which is necessary or normally required as a part of such work, or is necessary or required to make each installation satisfactorily and legally operable, shall be performed by the Contractor as Incidental Work without extra cost to the City, as if fully described in the specifications and shown on the plans, and the expense thereof shall be included in the price bid.

103.04 CONFLICT BETWEEN PARTS OF SPECIFICATIONS. -- If there is any conflict between the requirements of these Standard Specifications, the Special Provisions and the plans, the Special Provisions shall govern over both the Standard Specifications and the plans, and the plans shall govern over the Standard Specifications.

## Section 104

### Utilities in Public Streets

104.01 GENERAL. --If the plans include a utility occupancy plan, or plans, showing the approximate locations in public streets, and other details, of pipes, conduits, structures and other utility facilities owned or controlled by any person, company, firm, corporation or agency, private or governmental, hereinafter referred to as Owners, it is understood that the City makes no representation as to the completeness or accuracy of said plan or plans and assumes no responsibility therefor.

In the absence of such utility occupancy plans, Bidders may inspect in the offices of the Bureau of Engineering, Department of Public Works, such plans and other information relative to Sewer or Auxiliary Water Supply System for Fire Protection facilities, and information regarding other facilities which may have been made available to the City by the Owners. As in the case of utility occupancy plans, the City makes no representation regarding, and assumes no responsibility for, any such information made available to Bidders.

Bidders are instructed to satisfy themselves regarding the locations and other details of utility facilities by applying to the Owners for such information as they require.

It shall be the duty of the Contractor to inform the Owners, including City departments, of pipes, wires, conduits and other utility facilities, of his intended operations a reasonable time in advance thereof so as to permit the Owners to make suitable markings on the street surface of the locations of such facilities. After such markings have been satisfactorily made, the Contractor shall maintain them as long as necessary for the proper conduct of the work.

Except as otherwise hereinafter provided, pipes, wires, conduits and other utility facilities located in or over the location of the work shall be removed or adjusted by the Contractor as necessary to permit the prosecution of the work. The Contractor shall perform all work in such manner as to avoid damage to such pipes, wires, conduits and other utility facilities in the process of their removal or adjustment, and also so as to avoid damage to such facilities lying outside of or below a required excavation or trench area and intended to remain in place.

104.02 GOVERNMENTAL FACILITIES. --The Contractor shall satisfactorily support, work around, and protect, as approved by the Engineer, all facilities, whether shown on the plans or not, which exist within any excavation and which are owned or controlled, and maintained, by a City department or other authority in the exercise of a governmental function. By "facilities owned or controlled, and maintained, in the exercise of a governmental function" is meant such facilities as traffic control, lighting, police communication and fire alarm

systems, and all conduits, wiring and related appurtenances for such systems, sewers and sewer structures, and pipes and facilities of the Auxiliary Water Supply System for Fire Protection.

Auxiliary Water Supply for Fire Protection facilities, if encountered, shall be supported by a minimum of one cable with turnbuckle, a strongback, and a beam spanning the trench; however, where a joint falls within the trench area, a cable with turnbuckle shall be placed on each side of the joint.

In the case of vitrified clay pipe side sewers and culverts he encounters, the Contractor may elect, in lieu of supporting such side sewers and culverts, to cut and restore those portions of the side sewers and culverts which obstruct the prosecution of the work, provided that he complies with provisions regarding the handling and disposal of seepage, storm water and sewage specified elsewhere in these Standard Specifications.

Supporting, working around, and protecting existing governmental facilities and cutting and restoring portions of side sewers and culverts, as set forth above, shall be considered Incidental Work and no direct or additional payment will be made therefor.

Any governmental facilities that require removal, adjustment or relocation to avoid direct physical conflict with the facilities to be constructed under the contract shall:

- 1) be removed or adjusted by the Contractor in accordance with the provisions of the plans and specifications;
- 2) in the absence of such provisions, be removed or adjusted by the Contractor as Extra Work as set forth in Section 111; or,
- 3) be removed or adjusted by other suitable procedure at the City's expense.

The adjustment of manhole castings and other castings of governmental facilities, and the paving adjacent thereto, shall be done in accordance with the requirements of Section 202.

**104.03 NON-GOVERNMENTAL FACILITIES.** --The procedure to be followed with respect to utility facilities owned or controlled by any person, company, firm or corporation, or by City departments such as the Water Department and Municipal Railway, in the exercise of a proprietary function is covered by Sections 752, 753 and 754 of the Public Works Code (Part II, Chapter X, of the Municipal Code).

The method of application of the provisions of these Code sections is described in the following subparagraphs:

- 1) Pursuant to said Sections 752 and 753 of the Public Works Code, the Owners of pipes, wires, conduits, vaults, tracks or other utility facilities located in a street will, upon award of the contract, be notified by the Director to remove or adjust same to such extent as will allow the prosecution of the work according to the necessities thereof. The Owners will also be notified to commence the removal or adjustment of their facilities within ten (10) days of the notice so as to permit the Contractor's work to proceed without interference.

Each Owner, however, will be informed in the notice that he may

negotiate with the Contractor to defer any removal or adjustment of his facilities until the Contractor has removed the existing pavement, provided that these operations are coordinated to the extent as to cause no delays in the Contractor's work.

Should an Owner, in violation of the said Code sections, fail to comply with such notification, the Director will cause the necessary removals or adjustments to be made in accordance with said Section 754 of the Public Works Code.

- 2) If the cost of removing or adjusting a utility facility as contemplated hereinbefore, (a) materially exceeds the cost of so modifying the work that it can be done satisfactorily without the removal or adjustment of the facility, or (b) materially exceeds the increase in the cost of the Contractor's operations that would be occasioned to him by the uninterrupted presence of the facility if it were not removed or adjusted, then, in either case, the City will, if requested by the Owner, waive the requirement that the facility be removed or adjusted and allow it to remain in place, provided that the Owner obtains the consent of the Contractor to such waiver in return for such compensation, if any, by the Owner as may be just and equitable and no expense is occasioned either directly or indirectly to the City by such waiver, and further provided that the Owner agrees to compensate the City for the expense, if any, of revising the plans and specifications as necessary to accomplish the appropriate modification of the work.

Should an Owner, in satisfying the requirements of the immediately preceding subparagraph, notify the Contractor of his intention to leave a facility in place, the Contractor shall, within ten (10) days, furnish to the Owner a quotation covering the entire cost of supporting, working around or protecting, as necessary, such facility.

In the event an Owner and the Contractor cannot agree upon the amount of the compensation, if any, to be paid by the Owner to the Contractor, then the Director, with or without the consent of the Contractor, will, if he determines that it would be uneconomic and contrary to the public interest to remove or adjust the utility facility, and if the Owner promises in writing to pay to the City the amount of the expense incurred by the City under the change order next hereinafter mentioned, waive the requirement that the facility be removed or adjusted and will issue an appropriate change order to the Contractor in accordance with the provisions of Section 111 to modify the work or to modify his operations, as the case may be, as necessary to accommodate the continued presence of the facility.

- 3) The adjustment of manhole castings and other castings of non-governmental facilities and the paving adjacent thereto, shall be done in accordance with the requirements of Section 202.

Pursuant to the provisions of (1), (2) and (3) hereinbefore, Bidders, therefore, shall not include in their bids any expense on account of the presence, or possible presence, of non-governmental utility facilities, except only that which might be included for adjustment of castings. This provision does not apply, however, to abandoned utility facilities. Any increase in the cost of the Contractor's operations occasioned by the presence and/or removal of the abandoned facilities shall be at the sole expense of the Contractor and no additional payment will be made by the former owners or by the City.

If during the course of the work an unexpected interference by a non-governmental utility facility is discovered, the Contractor shall immediately notify the Owner of the interfering facility so that the required procedure outlined in (1), (2) and (3) hereinbefore, as applicable, may be followed in a manner to cause no delay in the work.

**104.04 USE OF PAVEMENT BREAKER ADJACENT TO UTILITY FACILITIES LIMITED.** --In accordance with the requirements of Section 373 of the Public Works Code, the Contractor may use pavement breakers or other labor-saving devices; however, the use of any machine or device that breaks pavement by blows struck by a falling or driven hammer or weight is prohibited within a horizontal distance of 6 feet from any gas, sewer, water or Auxiliary Water Supply System pipe, communications duct or any other utility facility.

Such prohibition, however, shall not be construed as barring the use of hand tools or manually operated air tools such as jackhammers.

## Section 105

### Legal Regulations and Responsibility

**105.01 LAWS AND REGULATIONS.** --The Contractor shall keep himself fully informed of the Charter, Ordinances and regulations of the City, and of all Federal and State laws in any manner affecting the performance of the work or those persons engaged therein, and of all orders and decrees of governmental bodies or officials having any authority or jurisdiction over the same. He shall himself observe and comply with and shall cause all his agents, employees and subcontractors to observe and comply with said Charter and all such ordinances, regulations, laws, orders and decrees. The Contractor shall save harmless and indemnify the City and all its officers and employees against any claim or liability arising from or based on the violation of said Charter or any such ordinance, regulations, law, order or decree, whether by himself, his agents, employees or his subcontractors.

All construction and materials, including connections, supports, hangers, fastenings, and the like, shall be in full accordance with the requirements of the San Francisco Building Code, The National Board of Fire Underwriters, the Pacific Fire Rating Bureau, the State Fire Marshal, the Safety Orders issued by the Division of Industrial Safety of the State of California, the San Francisco Fire Department Bureau

of Fire Prevention and Public Safety, and all other prevailing codes and regulations having jurisdiction over construction or the structure.

The Contractor shall, prior to the start of work, secure the required building, plumbing, electrical, or other permits for the work covered by the specifications and shall pay the required fees therefor, except as such permits may have been previously obtained.

105.02 CONTRACTOR'S LEGAL ADDRESS. --The address given in the bid or Proposal is hereby designated as the legal address of the Contractor, but such address may be changed at any time by notice in writing, delivered to the Director.

The delivering to such legal address, or the depositing in the post-office in a postpaid wrapper, directed to the Contractor at the hereinbefore referred to address, of any plan, notice, letter or other communication, shall be deemed to be a legal and sufficient service thereof upon the Contractor.

105.03 DAMAGE TO WORK OR PROPERTY. --The Contractor shall be responsible for the safekeeping of, and shall protect, the work and materials from damage due to the nature of the work, the action of the elements, the carelessness of other contractors, or from any other cause whatsoever, until acceptance of the work. Should any such damage occur, he shall repair it at his own expense, and leave the work to the satisfaction of the Director in every particular.

Neither the City nor any of its officers, employees or agents assumes any responsibility for collecting indemnity from the person or persons causing damage to the work of the Contractor.

Any damage, arising from or in consequence of the execution of the contract, to tracks, pavements, curbs, landscaping, sidewalks, footings, walls, stairs, fences, sewerage and drainage structures, mains, pipes, valves, conduits, poles, wires, transformers, to adjoining work, or to any other improvement or property above or below the surface of the ground, whether private or public, shall be repaired at once by the Contractor at his own expense, or upon the occurrence of such damage the Contractor shall obtain from the owner of the damaged property a release from his liability for such damage. If, in the opinion of the Engineer, the best interest of the City requires such repair to be made prior to the execution of any part of the work included in the contract, the Engineer will so notify the Contractor who shall delay or discontinue the performance of that part of the work until the necessary repair has been made. Such delay shall not be considered unavoidable, and no extension of time for completion of the contract will be granted therefor. When ordered by the Engineer to make any such repair, the Contractor shall start work thereon within forty-eight (48) hours and shall prosecute the same with diligence to completion. Upon failure of the Contractor so to comply with such order, or upon his failure to make immediate emergency repairs which are necessary in the best interest of the City or of the public, the Director shall have authority to cause such repair to be made and to deduct the cost thereof from any money due, or which may become due, to the Contractor.

105.04 RESPONSIBILITY OF CONTRACTOR: INDEMNIFICATION. --

The Contractor shall take and assume all responsibility for the work. The Contractor shall bear all losses and damages directly or indirectly resulting to him, to the City, to parties specified in the Special Provisions, or to others, on account of the performance or character of the work, unforeseen difficulties, accidents or any other causes whatsoever.

The Contractor shall assume the defense of and indemnify and save harmless the City and County of San Francisco, the Director of Public Works, parties specified in the Special Provisions, and their officers and employees, from all claims, loss, damage, injury and liability of every kind, nature and description, directly or indirectly arising from the performance of the contract or work, regardless of responsibility for negligence; and from any and all claims, loss, damage, injury and liability, howsoever the same may be caused, resulting directly or indirectly from the nature of the work covered by the contract, regardless of responsibility for negligence.

105.05 CONTRACTOR'S WORKING CONDITIONS. --The Contractor's working conditions shall be governed by the provisions of Section 98 of the Charter of the City and County of San Francisco which read in part as follows:

"Every contract for any public work or improvement to be performed at the expense of the City and County, or paid out of moneys deposited in the treasury, whether such work is to be done directly under contract awarded, or indirectly by or under subcontract, subpartnership, day labor, station work, piece work, or any other arrangement whatsoever, must provide: (1) That in the performance of the contract and all work thereunder, eight hours shall be the maximum hours of labor on any calendar day; (2) that any person performing labor thereunder shall be paid not less than the highest general prevailing rate of wages in private employment for similar work; (3) that any person performing labor in the execution of the contract shall be a citizen of the United States; (4) that all laborers employed in the execution of any contract within the limits of the City and County shall have been residents of the City and County for a period of one year immediately preceding the date of their engagements to perform labor thereunder; provided, however, that the officer empowered to award any such contract may, upon application of the Contractor, waive such residence qualifications and issue a permit specifying the extent and terms of such waiver whenever the fact be established that the required number of laborers and mechanics possessing qualifications required by the work to be done cannot be engaged to perform labor thereunder.

"The term 'public work' or 'improvement, as used in this section, shall include the fabrication, manufacturing or assembling of materials in any shop, plant, manufacturing establishment or other place of employment, when the said materials are of unique or special design, or are made according to plans and specifications for the particular work or improvement and any arrangement made for the manufacturing,"

"fabrication or assembling of such materials shall be deemed to be a contract or a subcontract subject to the provisions of this section."

The Contractor's working conditions shall be further governed by the following provisions which are included herein in accordance with Ordinance No. 9.0923 adopted by the Board of Supervisors on April 30, 1934, as amended by Ordinance No. 9.9025, adopted October 19, 1936:

- 1) The Contractor shall pay to all persons performing labor in and about the work provided for in this contract, the highest general prevailing rate of wages as determined and fixed by the Board of Supervisors for the respective crafts and employments, including such wages for holiday and overtime work.
- 2) The Contractor shall insert in every subcontract or other arrangement which he may make for the performance of any work or labor on the work provided for in this contract, a provision that said subcontractor shall pay to all persons performing labor or rendering service under said subcontract or other arrangement, the highest general prevailing rate of wages as determined and fixed by the Board of Supervisors for the respective crafts and employments, including such wages for holiday and overtime work.
- 3) The Contractor shall keep or cause to be kept an accurate record showing the name, place of residence, citizenship, occupation and per diem pay, of each person engaged in the execution of this contract, and every subcontractor who shall undertake the performance of any of the work herein required shall keep a like record of each person engaged in the execution of the subcontract. All of said records shall at all times be open to the inspection of an examination by the duly authorized officers and agents of the City and County of San Francisco.
- 4) Should the Contractor, or any subcontractor who shall undertake the performance of any part of the work herein required, fail or neglect to pay to the several persons who shall perform labor under this contract, subcontract or other arrangement for the work, the highest general prevailing rate of wages as herein specified, he shall forfeit, and in the case of any subcontractor, so failing or neglecting to pay said wage, the original contractor and the subcontractor shall jointly and severally, forfeit to the City and County of San Francisco the sum of ten dollars (\$10.00) per day for each laborer, workman or mechanic employed for each calendar day or portion thereof, while they shall be so employed and not paid said highest general prevailing rate of wages, and the Director when certifying to the Controller any payment which may be come due under the terms of this contract will deduct from said payment the total amount of said forfeiture provided for, and the Controller, in issuing his warrant for any such payment, will deduct from the amount which would otherwise be due on said payment, the amount of said forfeiture or forfeitures as so certified.

- 5) No person performing labor or rendering service in the performance of any contract or subcontract for the work herein required shall perform labor for a longer period than 40 hours per week or 5 days of 8 hours each, except in those crafts in which a shorter work day now prevails by agreement in private employments. Any contractor or subcontractor who shall violate this subdivision of this section of this Ordinance shall be liable for the same penalties and forfeit as those specified in subdivision 4 of this section, for each laborer, mechanic or artisan employed for each calendar day or portion thereof whereon such laborer, mechanic or artisan is compelled or permitted to work more than the days and hours specified herein.

All applicable provisions of said Ordinance No. 9.0923 and No. 9.0925 shall be binding upon the Contractor and any of his Subcontractors affected thereby, and all provisions which said Ordinances No. 9.0923 and 9.0925 require to be incorporated into every contract for any public work or improvement, are by this reference hereby so incorporated and made part of the contract as if set forth at length therein.

105.06 PATENTS.—All fees or claims for any patented invention, article or arrangement that may be used upon or in any manner connected with the doing of the herein proposed work or any part thereof shall be included in the price bid for doing the work herein proposed, and the Contractor and his sureties shall protect and hold any and all departments of the City, together with all its officers and employees, harmless against any and all demands made for such fees or claims and against any and all suits and claims brought or made by the holder of any invention, patent, copyright or trademark, or growing out of any alleged infringement of any invention, patent, copyright or trademark, and before the final payment is made on account of the contract, the Contractor shall furnish acceptable proof to the Director of a proper release from all such fees or claims.

105.07 PAYMENT OF TAXES.—The contract bid prices for the work shall include full compensation for all taxes which the Contractor is required to pay, whether imposed by Federal, State or local government, including, without being limited to, City sales and Federal excise taxes. The Contractor shall furnish all proper forms and initiate all procedures to effect any exemption to which he may be legally entitled as to any tax on labor, services, materials, transportation, or any other work furnished pursuant to the contract. The City will make such certifications as are proper and necessary to the completion of such forms.

105.08 USE OF COMPLETED PARTS OF THE WORK BEFORE ACCEPTANCE.—During the period when the work is completed but not accepted, but the use thereof is necessary or required for the safety, health or convenience of the public as in the case of traffic signals, fire protection facilities, street lighting, sewers, and the like, the City

shall be allowed to take possession of, connect to, open for public use, or use, such completed parts of the work as applicable.

Prior to the date of acceptance of the work by the Director, all necessary repairs or renewals in the work or part thereof so used, not due to ordinary wear and tear, but due to defective materials or workmanship or to the operations of the Contractor, shall be made at the expense of the Contractor.

The use by the City of the work or part thereof as contemplated in this Section shall in no case be construed as constituting acceptance of the work or any part thereof. Such use shall neither relieve the Contractor of any of his responsibilities under the contract, nor act as a waiver by the City of any of the conditions thereof.

105.09 NO WAIVER OF LEGAL RIGHTS. --The City shall not be precluded or stopped by any measurement, estimate or payment, or by acceptance of, and payment for, the work, from showing the true amount and character of the work performed, or from recovering from the Contractor and his soreties such damages as the City may sustain by reason of the Contractor's failure to observe all the terms of the contract.

Neither acceptance of, nor payment for, the work, or any part of the work, nor any extension of time, nor any possession taken by the City, shall operate as a waiver of any portion of the contract, nor shall a waiver of any breach of the contract be held to be a waiver of any other or subsequent breach.

105.10 CORRECTION OF DEFECTS AFTER ACCEPTANCE. --The Contractor shall at his own expense make all necessary repairs and replacements to remedy in a satisfactory manner any and all defects in the work, or damages resulting from such defects, due to faulty materials or workmanship, or due to disturbance of or damage to City improvements by the Contractor's operations under the contract and contrary to the specifications, or due to other failure to comply with the specifications, when such defects occur:

- a) in any part of the surface work done under the contract, or in surface improvements of the City such as pavements, curbs, walks, tracks, poles, wires, walls, stairways, or other surface structures provided that such defect or defects be detected within one (1) year following the date of acceptance of the work;
- b) in any part of the subsurface work done under the contract, or in subsurface improvements of the City not included in the work under the contract, such as sewers, side sewers, culverts, other drainage structures, pipes, valves, conduits, conductors, or other subsurface structures, provided that such defects in such subsurface work, or distrubance of or damage to, said other improvements be detected within two (2) years following the date of acceptance of the work.

Should the Contractor, after written notification by the Director, fail to remedy promptly any such defect occurring as set forth hereinbefore under a) or b), or should the best interest of the City require an immediate remedy without the delay incident to such notification, the Director may cause such repairs, replacements or other remedy to be made, and the expenses so incurred, limited in case b) as provided hereinafter, shall be chargeable to, and shall be paid by, the Contractor, provided that such expense so incurred by the Contractor, or incurred by the City and paid by the Contractor, on account of disturbance of or damage to City improvements occurring as set forth under b) next hereinbefore, shall not exceed an amount equal to ten percent of the contract cost of all work to be done under the terms of the specifications, or such other amount as may be set forth in the Special Provisions, and further provided that the liability of the surety on the faithful performance bond, on account of such disturbance of or damage to City improvements occurring as set forth under b) next hereinbefore, shall likewise not exceed ten percent of the contract cost of all work to be done under the terms of the specifications, or such other amount as may be set forth in the Special Provisions.

Nothing in this Section shall be construed as a waiver, or impairment of any of the City's rights under the contract, or of any other recourse provided by law.

## Section 106

### Control of the Work and Materials

106.01 WORK TO BE DONE IN ACCORDANCE WITH PLANS AND SPECIFICATIONS. --The Contractor shall do all work and furnish all labor, material, equipment and tools necessary or required for the proper performance and completion of the work in an orderly and workmanlike manner within the time specified. The work shall be fully in accordance with the plans and specifications before consideration of acceptance by the Director.

Any change from the general locations and arrangement shown on the plans for mechanical and electrical equipment, ductwork, piping, conduit, appurtenances and the like, will be subject to the approval of the Engineer; further, exact locations thereof will be determined in the field by the Engineer.

The work shall be under the jurisdiction of the City Engineer acting as the representative of the Director.

Any defective work, or materials not conforming to the specifications or not equal to approved samples, will be rejected, and such defective work shall be immediately replaced, repaired, or otherwise corrected.

The Contractor shall at once remove from the work and its vicinity all rejected material of whatever kind, and upon his failure to do so within forty-eight (48) hours after notice from the Engineer, such ma-

terial may be removed by the Department of Public Works and the cost or removal deducted from any money due or that shall become due the Contractor under the contract.

All payments under the contract may be withheld until such defective work has been remedied and such defective material removed and replace, as provided hereinbefore.

106.02 ACCESS TO THE WORK. --During the performance of the work under the contract, the Director, the Engineer, and all agents and employees of the City acting within the scope of the duties entrusted to them may at any time, and for any purpose, enter upon the work, or the shops where such work may be in preparation, and the Contractor shall provide proper and safe facilities therefor, including, if necessary, the stopping of the work.

Other contractors performing work for the City may also, for all purposes which may be required by their respective contracts, enter upon the work.

106.03 INSPECTION. --All the work and materials and the manufacture and preparation of such materials, from the beginning of the construction until the final completion and acceptance of the work, shall be subject to the inspection of, and rejection with due cause by, the Engineer.

The Engineer may arrange for such assistance as he may deem necessary to inspect and test the materials to be furnished and the work to be done under the contract, and to see that the same is in accordance with the specifications. The Contractor shall furnish any information and assistance required for proper inspection.

No inspection will be furnished where, in the opinion of the Engineer, the number of men employed is too small to make proper progress.

The Contractor shall make application for inspection at least forty-eight (48) hours in advance of the commencement or resumption of the work.

Any work done during the absence of the Engineer shall be readily available for inspection, and if not so available, will be subject to rejection.

It is hereby understood and agreed that inspection of the work shall in no way relieve the Contractor of any of his obligations to fulfill the contract in accordance with the specifications, and defective work and materials may be rejected prior to the date of acceptance of the work notwithstanding that such defective work and materials may have been previously tested, inspected, and approved, or estimated for progress payments.

106.04 NIGHT AND WEEKEND WORK. --If Saturday, Sunday, Holiday, or overtime work is to be performed, the City Engineer's Office shall be notified at least twenty-four (24) hours in advance thereof.

106.05 CONTRACTOR'S SUPERINTENDENT, FOREMEN, AND WORKMEN. --The Contractor shall at all times during his absense be represented on the work by a superintendent, foreman or workman whom he has authorized to receive and carry out any instructions that may be given to him by the Engineer, and the Contractor will be held liable for the faithful observance of such instructions. Only competent and skillful men shall be employed on the work, and whenever the Engineer shall notify the Contractor in writing that any employee on the work is, in the opinion of the Engineer, incompetent, unfaithful, disorderly or refuses to carry out the provisions of the contract, such employee shall be permanently dismissed from the work.

106.06 INTIMIDATION. --Neither the Contractor nor his employees shall intimidate the Engineer or any of his representatives.

Intimidation by an employee of the Contractor shall be sufficient cause, at the request of the Engineer, for permanent dismissal of such employee from the work.

Intimidation by the Contractor shall be due cause for termination of the contract.

106.07 ENGINEER MAY FURNISH ADDITIONAL DRAWINGS. --During the progress of the work, such additional detail drawings as the Engineer may consider necessary will be furnished to the Contractor and shall be part of the specifications. It is the understanding that all such additional drawings will conform in their general intent with the contract documents.

106.08 CONTRACTOR TO FURNISH DRAWINGS AND LIST OF EQUIPMENT. --The Contractor shall furnish to the Engineer for approval six (6) copies of: a complete list of all equipment, descriptive material therefor, and layout, outline, and detail or working drawings, dimensioned and to scale. The information shall be submitted in sufficient time to prevent delays to the work. The approval of such drawings by the Engineer shall apply to general design only, and shall in no way relieve the Contractor from responsibility for errors, or omissions contained therein, nor from furnishing all labor and materials necessary in accordance with the specifications for the proper execution of the work.

One print of each drawing will be returned to the Contractor marked "To be corrected as shown", "Approved", or "Approved, except as noted". To be valid, an approval must bear the signature of the City Engineer. Prints marked "Approved, except as noted" need not be re-submitted unless specific request for such resubmission is made. Prints marked "To be corrected as shown" shall be corrected and six (6) copies thereof resubmitted for approval.

The City reserves the right to approve drawings in part only. Each drawing submitted shall be one of the following sizes:

28 1/2" x 18 1/2" with 3/4" border, making a 30" x 20" drawing.

21" x 15" with 1/2" border, making a 22" x 16" drawing.

The hereinbefore referred to drawings shall have a 2-inch binding edge, measuring to the left of the border line on the short side of the sheet.

14 3/4" x 10" with 1/2" border on three sides and 3/4" border on one 10" side, making a 16" x 11" drawing.

7 3/4" x 10 1/2" with 1/4" border on three sides and 1/2" border one 10 1/2" side, making an 8 1/2" x 11" drawing.

The extent to which the Contractor is responsible for the submission of lists of equipment, descriptive literature, and plans shall be, as described hereinafter.

Construction material, of a general unspecialized nature and covered by widely-accepted gradings or standards, such as timber, pipe, steel conduit, and wire insulated for 600 volts or less, if in quality in every respect as specified, need not be listed nor will drawings or descriptive material be required.

Products generally used but intended for a special purpose, or for which there is no widely-accepted standard, such as special pressure pipe, non-metallic conduit, prefabricated structural or trim elements, junction and pull boxes, light bulbs, chain link fence, paint, tile, sprinkler heads, plumbing fixtures and trim, and wire and cable for above 600-volt service, together with the manufacturer's name and trade designation thereof, shall be included in the list of equipment for approval, but drawings and descriptive material will not be required, except that factory test results will be required for the wire and cable.

Equipment requiring maintenance, that for which there are replacement parts, major special-purpose manufactured or fabricated items, or items of which there may be more than one model by the same manufacturer, and all reinforcing and structural steel elements, shall be listed, and all the specified descriptive material and drawings therefor, including wiring diagrams and complete operating and maintenance instructions, shall be furnished. This equipment includes but is not limited to pumps, sidewalk doors, fire escapes, drainage gates, compressors, motors, generators, valves, switchboards, heating equipment, sirens, boilers, tanks, machinery, traffic signal controllers, cabinets and pedestals, traffic and pedestrian signals including mounting assemblies and standards, traffic safety lights including shaft, bracket arms, shaft caps and luminaires, and mechanical, electrical and electronic controls and equipment. Catalog sheets meeting the specified requirements may be substituted for the required drawings.

No equipment or material for which listings, drawings, or descriptive material is required shall be installed until the Engineer in the field has on hand approved copies of such lists and drawings.

106.09 QUALITY OF MATERIALS. — These Specifications contemplate the use of first-class new materials throughout the work, and it is understood that any material for which no particular specification is given shall be the best of its class or kind.

106.10 SOURCES AND MANUFACTURE OF MATERIALS. --Pursuant to the provisions of Title I, Division 5, Chapter 4, Article 1 of the California Government Code, and subject to the exceptions therein contained, only unmanufactured materials produced in the United States, and only manufactured materials manufactured in the United States, shall be used in the performance of this contract; provided, however, that these requirements concerning unmanufactured and manufactured materials shall not apply in any instance where enforcement thereof would conflict with any law to which the said Government Code provisions are subordinate. For purposes of interpreting the foregoing proviso, the word "law" shall include, but not be limited to, the constitution, treaties and statutes of the United States; bilateral and multilateral international compacts, agreements and trade agreements of the United States, other than treaties, including, but not limited to, the General Agreement on Tariffs and Trade (GATT); and protocols of adherence to, or permanent or provisional application of, any such international agreements.

106.11 TRADE NAMES. --Whenever any article or any class of materials is specified by a trade name, or by the name of any particular patentee, manufacturer or dealer, it shall be and is mutually understood that such name is followed by the phrase "or approved equal," and to mean and specify the article or class of materials described, or any other equal thereto in quality, finish and durability and equally as serviceable for the purpose for which it is intended, subject to the approval and acceptance of the Director.

106.12 SUBSTITUTIONS. --The Contractor, within thirty (30) calendar days after the official date for the commencement of the work, or within such shorter period of time dictated by the length of time allowed for completion of the work under the contract, shall submit for approval to the City Engineer six (6) copies of a complete list of all materials, articles or equipment which he proposes to substitute in place, and as the equal, of materials, articles or equipment which are specified by trade names or by the names of any particular patentee, manufacturer or dealer. Failure to submit such list within that time will be deemed adequate and reasonable grounds for refusal by the Director to consider any subsequent proposed substitutions. Any items omitted from a duly submitted list may likewise be barred from subsequent consideration.

Six (6) copies of a complete description of each proposed substitute, including layout, outline and detail or working drawings complete with all necessary dimensions and other pertinent information, catalogs, and test and other necessary data, shall be furnished in time to permit investigation and approval without delay to the work. No approval shall be valid without the signature of the City Engineer.

If tests and samples are necessary, as determined by the Engineer, to establish the quality or equality, as applicable, of any materials, articles or equipment, the tests shall be made and samples shall be furnished, as applicable, at the sole expense of the Contractor; further,

such tests shall be made by an unbiased laboratory. Any tests the City elects to make in its own laboratory will be made at no cost to the Contractor.

The City reserves the right to approve drawings in part only.

106.13 SAMPLES AND TEST SPECIMENS. —When required elsewhere herein, or in the Special Provisions, test specimens or samples of materials, appliances and fittings to be used or offered for use in connection with the work shall be prepared and furnished to the Engineer at the Contractor's expense, and in such quantities and sizes as may be required for proper examination and tests, with information as to their sources, and with all cartage charges prepaid.

All samples and test specimens shall be submitted in ample time to enable the Engineer to make any tests or examinations necessary, and the Contractor will be held responsible for any loss of time due to his neglect or failure to deliver the required samples to the Engineer. Laboratory tests and examinations elected by the City to be made in its own laboratory will be made at no cost to the Contractor; all other tests shall be at the sole expense of the Contractor.

106.14 TESTS. —All tests of completed work required by the specifications, by City Ordinances or by law, shall be made under the direction of the Engineer, by and at the expense of the Contractor, who shall repair, at his own expense, all damage resulting therefrom.

Whenever required by the Engineer, the Contractor shall furnish all tools, labor and materials necessary to make an examination of any work under these specifications that may be completed or in progress. Should such work be found defective, the cost of making such examinations and reconstruction shall be defrayed by the Contractor. Should the work be found to be satisfactory, the work will be paid for by the City, under force account in accordance with the provisions of Section 111.

In order that the Engineer may determine whether the Contractor has complied or is complying with the requirements of the contract which are not readily enforceable by inspection and tests of the work and materials, the Contractor shall upon request submit properly authenticated documents or other satisfactory proof of his compliance with such requirements.

## Section 107

### Prosecution and Progress of Work

107.01 SUBCONTRACTING. --Subcontracting shall be in accordance with the governing regulations regarding subcontracts, Sections 6.48 to 6.52, inclusive, of the San Francisco Administrative Code, which Sections govern the designation of, failure to specify, and substitution of subcontractors, and assignment, transfer and performance of subcontracts.

The Contractor shall give his personal attention to the faithful prosecution of the work and shall keep the work under his personal control except as provided in the case of subcontracts. No subcontract, however, shall relieve the Contractor of any of his liabilities or obligations under this contract. The Contractor shall not, either legally or equitably, assign any of the moneys payable under this contract, or his claim thereto, unless with the consent of the Director.

107.02 COMMENCEMENT AND PROSECUTION OF THE WORK. --After the signing of the contract, and its certification by the Controller as required by Section 86 of the Charter, the Director will designate the official date for the commencement of the work, and will notify the Contractor thereof. The Contractor shall not commence the work, nor incur any expense in connection therewith, before he is notified by the Director of such official date for the commencement of the work. The Contractor shall notify the City Engineer, in writing, not less than two (2) working days in advance, of the actual date he will start the work to be done under the contract, shall commence such work within ten (10) calendar days after such official commencement date, and shall prosecute it diligently thereafter at a rate sufficient to enable him to complete the work within the time specified in the Special Provisions. The Contractor shall be entirely responsible for any delay in the work caused by his failure to give notice of the actual date he will start the work.

The employment of sufficient equipment, labor force, and hours and shifts of work, to ensure completion of the work within the time allowed, is the responsibility of the Contractor. All costs occasioned by such implementation will be considered to be included in the prices bid and no direct or additional payment will be made therefor.

The Contractor shall make all measurements necessary for the proper prosecution of the work except those specified to be made by the Engineer.

107.03 PROGRESS SCHEDULE. --Prior to starting the work, the Contractor shall submit to the Engineer a progress schedule showing his proposed sequence of operations in the performance of the work, and the estimated dates of starting and finishing the various major parts of the work. The schedule shall conform to the specified time for completion of the work; for equipment and materials requiring special fabrication or otherwise not readily available for purchase,

shall show and be in accordance with the order and delivery dates affecting, or critical with respect to, such time of completion; and shall be subject to the approval of, and modification by, the Director.

When, for the convenience, health, or safety of the public, it is necessary to accelerate any part of the work, the Contractor shall, when so directed, concentrate his efforts on such part of the work.

107.04 RECORDS TO BE MADE AVAILABLE. --During the performance of the contract, the Contractor, when requested, shall give the Engineer full and correct information, to the extent required by law, or for force account records, as to the number of men employed in connection with each subdivision of the work, the classification, rate of pay, citizenship status, and address of each man, and the cost, source, and amount of each class of materials, equipment and tools used in each subdivision of the work.

107.05 COOPERATION OF CONTRACTOR AND COORDINATION WITH OTHER WORK. --Should construction work, or work of any other nature, be underway by other forces or by other contractors within or adjacent to the limits of the work at the time the work was advertised for bids, the Contractor shall cooperate with all such other contractors or forces to the end that any delay or hindrance to their work will be avoided. The cost of such cooperation will be considered as included in the prices bid and no direct or additional payment will be made therefor.

The City reserves the right to perform other or additional work, within or adjacent to the limits of the work specified, at any time by the use of other forces. In the event that the performance of such other or additional work materially increases or decreases the Contractor's costs, the work and the amount to be paid therefor will be appropriately adjusted in accordance with the provisions of Sections 101.06 and 111.

The Contractor shall not hinder, nor interfere with, any company, agency or individual having underground facilities, in removing, relocating, relaying or otherwise protecting such structures, mains pipes, conduits, lines, or railroad, or other, facilities and appurtenances.

No manhole, vault or other utility appurtenance shall be entered without the permission of the utility company or authority concerned.

107.06 CONTRACTOR TO MAINTAIN TELEPHONE SERVICE IN SAN FRANCISCO. --The Contractor shall maintain, in the City and County of San Francisco, during the continuance of his contract, telephone service at all times between 8:30 a.m. and 5:00 p.m. (Sundays and legal holidays excepted) whereby either he, or his authorized representative, may be readily available for communication.

107.07 LINE AND GRADE FOR THE WORK. --All the work shall be done in accordance with the lines, elevations and grades shown on the plans. The necessary survey stakes, marks or points for such lines, elevations and grades will be set by the Engineer. Unless otherwise specified or shown on the plans, all elevations refer to San

Francisco City Datum, which is 11.67 feet above Presidio Mean Lower Low Water.

The Contractor shall keep the Engineer informed, in advance, of his intended sequence of operations so that the necessary survey stakes, marks, or points may be set, and associated measurements made, with a minimum of inconvenience and delay.

The Contractor shall have available at all times an accurate spirit level and straight edge suitable for transferring elevations from established points to the work.

No lines or grades will be furnished when, in the opinion of the Engineer, the Contractor's forces are inadequate to make the proper progress.

When required by the work, the Contractor shall assist the Engineer in setting survey stakes, marks or points by furnishing temporarily, as Incidental Work, necessary hand tools, stake materials and labor.

Any work required to further reset any stake, mark or point destroyed or disturbed, and once subsequently reset, shall be at the sole expense of the Contractor and will be deducted from moneys due him under the Contract.

107.08 SURVEY MONUMENTS AND BENCH MARKS. --The Contractor shall bring to the attention of the Engineer all survey monuments, bench marks, property line marks and the like, encountered on the work.

Even though removal of survey monuments, bench marks, or other survey marks or points will be required in the normal prosecution of the work, such monuments, marks or points shall not be removed or disturbed until referenced or relocated by the Engineer or other agency or party having an interest therein, and then removed only at the time and in the manner specifically approved by the Engineer.

The Contractor shall bring all City monument frames within the limits of the work to grade, with the express proviso that any and all work associated with the removal and relocation of such frames, with their covers, shall be under the direct supervision of the Engineer, and all such work shall be considered Incidental Work.

The cost of re-establishing and resetting survey monuments, bench marks or other survey marks or points lost or destroyed through the carelessness or negligence of, or inadvertently by, the Contractor or his employees, shall be at the sole expense of the Contractor and shall be deducted from moneys due him under the contract.

107.09 EXTENSIONS OF TIME ALLOWED FOR COMPLETION OF WORK. --Extensions of the time allowed in the Special Provisions for completion of the work shall be in accordance with and pursuant to the provisions of Ordinance No. 9484 (Series of 1939), which Ordinance by this reference is incorporated in, and made a part of the contract. The Ordinance reads, in part, as follows:

"Section 6.1. EXTENSION OF TIME. The awarding officer, board or commission may extend the time for completion of the work under a contract, upon the awarding officer, board or commission"

"finding that such work cannot be completed within the specified time because of an unavoidable delay as herein restricted. Such extensions shall be in writing but in no event shall any extension be granted subsequent to the issuance of a certificate of final acceptance.

"Section 6.2. NOTICE OF DELAY. The Contractor shall promptly notify the awarding officer, board or commission in writing of all anticipated delays in the prosecution of the work and, in any event, promptly upon the occurrence of a delay. Said notice shall constitute an application for an extension of time only if said notice requests such extension and sets forth the contractor's estimate of the additional time required together with a full recital of the causes of unavoidable delays relied upon. The awarding officer, board or commission may take steps to prevent the occurrence or continuance of the delay, may classify the delay as avoidable or unavoidable, and may determine to what extent the completion of the work is delayed thereby.

"Section 6.3. UNAVOIDABLE DELAYS. Unavoidable delay is an interruption of the work beyond the control of a contractor and which interruption the contractor could not have avoided by the exercise of care, prudence, foresight and diligence. Such delays include and are limited to acts of God; acts of the public enemy; adverse weather conditions; fires; floods; windstorms; tornadoes; wars; riots; insurrections; epidemics; quarantine restrictions; strikes; lockouts; sit-downs; slow-downs; other labor trouble; labor shortages; inability of contractor to procure labor; material shortages; inability of contractor to procure material; fuel shortages; freight embargoes; accidents; acts of a governmental agency; priorities or privileges established for the manufacture, assembly or allotment of materials by order, decree, or otherwise of the United States or by any department, bureau, commission, committee, agent, or administrator of any legally constituted public authority; changes in the work ordered by the contracting officer, board or commission insofar as they necessarily require additional time in which to complete the entire work; the prevention by the City and County of San Francisco of a Contractor from commencing or prosecuting the work; the prevention of a contractor from commencing or prosecuting the work because of the acts of others, excepting the contractor's sub-contractors; the prevention of a contractor from commencing or prosecuting the work because of the failure of the City and County of San Francisco to furnish the necessary materials, when required by the terms of a contract and when requested by the contractor in the manner provided in said contract; and, inability to procure or failure of public utility service. The duration of said unavoidable delays shall be limited to the extent that the commencement, prosecution and completion of the work are delayed thereby, as determined by the awarding officer, board or commission.

"Section 6.4. UNAVOIDABLE DELAYS OTHER THAN THOSE STATED IN SECTION 6.3. Upon the recommendation of the award-

"ing officer, board or commission, the Board of Supervisors may provide by resolution for extensions of time relating to specific contracts for causes other than those stated in section 6.3 hereof which the contractor could not have avoided by the exercise of care, prudence, foresight and diligence.

"Section 6.5. AVOIDABLE DELAYS. Avoidable delays in the prosecution or completion of any work shall include (a) all delays which could have been avoided by the exercise of care, prudence, foresight and diligence on the part of the contractor, (b) delays in the prosecution of parts of the work, which may in themselves be unavoidable but do not necessarily prevent or delay the prosecution of other parts of the work, nor the completion of the whole work within the time specified, (c) reasonable delays resulting from time required by the City and County of San Francisco for approval of plans submitted by the Contractor and for the making of surveys, measurements and inspections, and (d) delays arising from interruptions occurring in the prosecution of the work on account of the reasonable interference from other contractors employed by the City and County of San Francisco, which do not necessarily prevent the completion of the whole work within the time specified.

"Section 6.6. EXTENSION OF TIME DOES NOT WAIVE CITY'S RIGHTS. The granting of an extension of time because of unavoidable delays shall in no way operate as a waiver on the part of the City and County of San Francisco or the awarding officer, board or commission of the right to collect liquidated damages for other delays or of the right to collect other damages or of any other rights to which the City and County of San Francisco is entitled.

"Section 6.7. LIQUIDATED DAMAGES. Any contract may provide a time within which the contract work or portions thereof shall be completed and may provide for the payment of agreed liquidated damages to the City and County of San Francisco for every calendar or working day thereafter during which such work shall be uncompleted.

"The execution of a contract by a contractor shall constitute acknowledgment by the contractor that he understands, has ascertained and agrees that the City and County of San Francisco will actually sustain damages to the amount fixed in said contract for each and every calendar or working day during which the completion of the work required shall be delayed beyond the expiration of the time fixed for such completion or such extensions of said time as have been allowed pursuant to the provisions hereof.

"There shall be deducted from any money due or to become due to the contractor subsequent to such time for completion of the entire work and extensions of time allowed pursuant to the provisions hereof, a sum representing the then accrued liquidated damages.

"Such deduction shall be considered not as a penalty but as the agreed monetary damage sustained by the people of the City and County of San Francisco because the contractor failed to perform and complete the work within the time fixed for completion of such extensions of said time as have been allowed pursuant to the provisions hereof."

"Should the money due or to become due to the contractor be insufficient to cover such agreed liquidated damages, then the contractor forthwith shall pay the remainder to the City and County of San Francisco.

"Section 6.8. NO PAYMENT TO BE MADE BY CITY FOR DELAYS. No damages or compensation of any kind shall be paid to the contractor because of delays in the progress of the work, whether such delays be avoidable or unavoidable.

"Section 6.9. CONTRACTS AWARDED IN CONSIDERATION OF RELATIVE TIME ESTIMATES OF BIDDERS FOR COMPLETION OF THE WORK. When any award of contract has been made in consideration, in whole or in part, of the relative time estimates of bidders for the completion of the work, the provisions of sections 6.3, 6.4 and 6.5 shall not apply and no extension of time may be granted on such contract beyond the time specified for completion, unless the liquidated damages for each day the work is uncompleted beyond the specified time shall be collected; provided, however, that this shall not apply to unavoidable delays due to acts of God.

"Section 6.10. SECTIONS TO BE INCORPORATED IN EVERY CONTRACT. The provisions of sections 6.1 through 6.9 hereof shall be included in every contract or specification for every public work or improvement, as public work or improvement is defined in Ordinance No. 9.0923 and Part II Chapter X Article 3 Section 75 of the San Francisco Municipal Code, whenever such contract and the published notice soliciting sealed bids therefor provide for liquidated damages to the City and County of San Francisco for every day during which the contract is uncompleted beyond a specified time.

"Section 6.11. MODIFICATION OF CAUSES OF UNAVOIDABLE DELAY AUTHORIZED. The awarding officer, board of commission may provide in any particular contract, using specific language, that interruption of the work due to one or more of the causes of unavoidable delays set forth in section 6.3 hereof is not a cause of an unavoidable delay under that particular contract. The awarding officer, board commission may also provide in any contract that one or more causes of unavoidable delay set forth in section 6.3 hereof shall be restricted to circumstances specified in said contract."

107.10 LIQUIDATED DAMAGES FOR DELAY IN COMPLETION OF WORK. --In accordance with the provisions of Ordinance No. 9484 (Series of 1939), which ordinance is incorporated in, and is a part of, the Special Provisions, it is understood, agreed, and provided that liquidated damages of the amount specified in the Special Provisions will be paid by the Contractor to the City for each and every calendar day during which the work shall be uncompleted after the expiration of the time allowed for the completion of work in the Special Provisions or after the expiration of such extensions of time as may be granted pursuant to the provisions of Ordinance No. 9484.

107.11 TERMINATION OF, OR DEFAULT ON CONTRACT. -- All conditions of the contract are considered material, and failure by the Contractor to comply with any of said conditions shall be deemed a breach of the contract. Upon the occurrence of such breach, the City shall have the right, whether any alternative right is provided or not, to declare the contract terminated, and the issuance by the Director of an order stating that the contract is terminated, and the service of a copy of said order upon the Contractor shall be deemed a complete termination of the contract. Upon the contract being so terminated, the City may retain all sums due under the contract and both the Contractor and his sureties shall be liable upon his bond for all losses, expenses and damages caused to the City by reason of his failure to complete the contract.

Time shall be of the essence of the contract.

If the Contractor fails to begin the work, as required by the contract, or if at any time he refuses, neglects, or fails, in the judgment of the Engineer, to have available on the work a sufficient amount of suitable materials, adequate equipment and a sufficient force of competent workmen, to insure completion of the work within the specified time, or if the Contractor fails to perform the work in good faith in an acceptable manner in accordance with the specifications, or if he refuses, neglects or fails for any reason whatsoever to observe any of the conditions and covenants of the contract, or if he abandons the work, the Engineer may give the Contractor written notice, specifying the default and requiring its correction. Should the Contractor for three (3) days after receipt of such notice of default, fail to proceed in accordance therewith to remedy such default, he shall, when so ordered in writing by the Director, discontinue or not begin the work or any designated part of the work, and any or all payments due or that may become due to the Contractor may be withheld by the City until the completion of all the work included in the contract.

After service on the Contractor of such order to desist from the work or part thereof, the Director may take possession of the work or such designated part thereof, and may use any or all of the Contractor's plant, tools, equipment, materials or other property on the work, none of which shall be removed by the Contractor so long as they may be required for the work, and the Director may by contract or otherwise provide the superintendence, workmen, materials, appliances and equipment necessary for the completion of, and may complete, the work or such designated part thereof. The whole of the expense so incurred for the completion of the work or part thereof, together with all damages, liquidated or otherwise, sustained or to be sustained by the City shall be deducted from the fund or appropriation set aside for the purpose of the contract, and shall be charged to the Contractor as if paid to him. In case the amount of such expenses and damages shall exceed the sum which would have been payable under the contract if completed entirely by the Contractor, the amount of such excess shall be paid to the City by the Contractor, and both he and his sureties shall be liable to the City therefor; and in case the amount of such expenses and damages shall be less than the sum which would have been payable under

the contract if completed entirely by the Contractor, he shall be entitled to the amount of the difference, subject to all the terms of the contract.

The Contractor shall continue to prosecute to completion all the work from which he has not, as hereinbefore provided, been ordered to desist, and he shall cooperate with, and in nowise hinder or interfere with the forces employed by the City, by contract or otherwise, to do any designated part of the work as hereinbefore specified.

Upon completion of all the work included under the contract, the Contractor shall be entitled to the return of all of his materials which have not been used in the work, of his plant, tools, equipment and other property, provided, however, that he shall have no claim on account of usual and ordinary depreciation, loss, wear and tear.

## **Section 108**

### **Incidental Work**

108.01 GENERAL.— In accordance with the provisions of Section 101.08, payment for all work incidental to the completion of the work set forth under the contract shall be included in the lump sum of unit price or prices bid, and no direct or additional payment will be made for any such Incidental Work.

Set forth in the following decimally numbered Sections are typical examples of Incidental Work and requirements governing such work. In addition, elsewhere in the Standard Specifications or Special Provisions, or on the plans, may be set forth other work, including the furnishing and installation of materials and products, and requirements governing the Contractor's operations. Without exception, all such work not specifically set forth for payment in the Schedule of Bid Prices shall be done as Incidental Work, no direct or additional payment will be made therefor, and the cost thereof shall be included in the price or prices bid.

When there is doubt regarding the proper allocation of cost of any Incidental Work, the Bidder shall include such cost in the price bid for the Bid Item, or Items, he deems most appropriate.

#### 108.02 FIELD OFFICE

General.— When required in the Special Provisions, the Contractor shall provide, maintain, and subsequently remove as his property, a field office of one of the three standard types, or other type, as therein specified, for the free and exclusive use of the Engineer and his representatives.

The minimum gross floor area required for the field office may be reduced 25 percent if a modern trailer, equipped as specified, is provided.

The field office, equipped as specified, shall be available at the site for the Engineer's use prior to the start of any work in the field under the contract. The field office shall be located where directed, and relocated when necessary, and shall be of substantial weatherproof construction with adequate window area. The field office shall be secured

with keyed cylinder-type locks. The Contractor shall maintain the field office and its appurtenances in good repair and acceptable appearance and shall provide daily cleaning service and constant maintenance and replenishment, as applicable, of paper towels, paper cups, soap, toilet paper, potable water, telephone service, electric lighting, and heating.

Every field office shall have an approved heater. The heater, if not electric, shall be directly vented to the outside of the field office. Coal oil heaters shall not be used.

The Contractor shall be responsible for the safety of engineering instruments and equipment belonging to the City and stored in the field office.

Standard Types. - Standard type field offices shall be of a floor area not less than that specified and shall contain the following listed equipment and facilities:

Standard Type 1 - Minimum gross floor area 300 square feet, with separate vented sanitary compartment containing:

Toilet and Toilet Paper Holder

Washbasin on Stand

Paper Towel Dispenser

Paper Cup Dispenser

Mirror at least 12 inches x 18 inches

The field office shall also contain:

Two (2) Exit Doors

Suitable Lockers with keyed cylinder-type locks for survey instruments and clothing

Drafting Table not less than 3 feet x 6 feet, with Stool

Adequate Plan Racks and Hangers

Bulletin Board

Book Shelves

Small Library Table with Lockable Drawers

Three (3) Chairs

Adequate Electric Lighting Facilities

Approved Space Heater

One-Party, Unlimited Call, Telephone with 12-foot

Extension Cord

Approved First Aid Kit

Standard Type 2 - Minimum gross floor area 120 square feet, equipped as specified for Standard Type 1 except that the library table and the separate sanitary compartment and toilet need not be included and only one exit door is required. The cup dispensers and mirror, however, shall be furnished.

Standard Type 3 - Minimum gross floor area 80 square feet, equipped as specified for Standard Type 1 except that sanitary facilities, lockers, drafting table with stool, and electric lighting, need not be included, the number of chairs may be reduced to two, and only one exit door is required.

108.03 SANITARY CONVENIENCES. - In the event no field office is required, or the furnished field office is not equipped with sanitary con-

veniences, the Contractor shall provide approved adequate separate facilities for the use of the Engineer, either by provision of such facilities at the site or by making arrangements with the owners of existing facilities immediately adjacent to the work.

Separate sanitary conveniences shall also be provided for the use of the workmen.

Sanitary conveniences shall be available for use at the site prior to the start of work in the field under the contract. The sanitary conveniences shall be maintained, relocated, and removed by the Contractor at the direction of the Engineer. The Contractor shall obey and enforce such sanitary regulations as may be prescribed by the Department of Public Health of the City.

108.04 EXCAVATING.—The Contractor shall do all pavement excavation and all trench, common, and structural excavation, necessary, or required, to satisfactorily accomplish the work, all in accordance with the applicable requirements set forth in the Special Provisions and these Standard Specifications.

108.05 REMOVAL OF SUBSURFACE OBSTACLES.— Subsurface obstacles, regardless of size, shape or type of material, and whether or not shown on the plans or specified, which may be encountered within the limits of the excavation necessary for the work, shall be removed by the Contractor as Incidental Work and no direct or additional payment will be made for such removal.

Examples of subsurface obstacles are boulders, roots, native rock formations, building debris and rock used as fill material, abandoned facilities such as sewers and sewer structures, water and other utility pipes, mains and ducts, structures of wood, steel or concrete, piles, walls, foundations, slabs, pavement materials, cable car yokes, rails, and other iron and steel.

Where excavation is designated to be paid for under a Bid Item, no reduction in the pay quantity thereof will be made on account of the presence of any subsurface obstacle.

The Contractor is reminded that in accordance with the requirements of Section 101.08, the determination of circumstances and conditions affecting the cost of the work, including any test holes, is his responsibility.

108.06 WATER DAMAGE AND DISPOSAL OF WATER.— The Contractor shall protect the work from water damage, shall keep excavations dry, shall dispose of water from all sources, shall do all necessary pumping, and shall install suitable conduits to remove and divert all sanitary, ground water, tidewater, and storm water flow from the work. Dry weather sewage shall be diverted to sewers leading to treatment plants and shall in no case be diverted to a sewer leading directly to the Bay or Ocean.

On file in Room 367, City Hall, and available for inspection, are maps and records indicating sewers which are interconnected with the

work. The Contractor shall be responsible for familiarizing himself with such sewers.

The Contractor is cautioned that any quantities of flows shown on the plans or included in the Special Provisions are estimated and are furnished to the Contractor for general guidance only, and that the City takes no responsibility for the accuracy of these estimates nor for any deductions or conclusions that the Contractor may make therefrom. In any case, the Contractor will not be relieved of any responsibility for the handling and disposal of water and sewage.

The Contractor shall not allow water originating on or due to his work, or which he is obliged to handle and dispose of, to discharge upon the work or into the trenches of another contractor.

108.07 LAGGING AND SHEET PILING.--The Contractor shall furnish, install and maintain lagging, sheet piling, timbering, shoring, and bracing, as necessary to safely support the sides of excavations and to prevent any movement of the adjacent ground, pavement, improvements, or property, as the case may be.

The manner of bracing excavations shall be in accordance with the rules, orders and regulations of the State of California Division of Industrial Safety.

Adequate space shall be provided within the limits of the excavation, sheet piling, lagging, or bracing, as the case may be, to allow for proper construction of the structure to the alignment and cross sections shown on the plans.

Should such supports be in any way insufficient for their purpose, the Contractor shall at once provide additional and adequate supports. Additional supports ordered by the Engineer shall in no way relieve the Contractor of his responsibility for safely supporting the sides of the excavation.

Unless otherwise specified or approved, sheet piling, lagging, and bracing shall be removed during backfilling. Vacancies left by such removal shall be immediately backfilled with acceptable material compacted into place.

Lagging and sheet piling for excavations for sewers, pipes and structures in street areas shall be as set forth in Section 301.01.

108.08 BACKFILLING AND CONSTRUCTING EMBANKMENT. --The Contractor shall do all backfilling and constructing embankment necessary, or required, to satisfactorily complete the work and he shall backfill all excavations to the elevations shown on the plans, that of the adjacent existing ground surface, or the required subgrade, as the case may be.

Backfill and embankment shall consist of approved site-excavated or other material, free of debris, wood and other organic or deleterious matter.

All backfill and embankment shall be, and shall be placed and compacted, in accordance with the applicable of the requirements set forth elsewhere in these specifications.

Backfilling above or against any facilities to be constructed under the contract shall not commence until after such facilities have been properly constructed and inspected. Backfill shall be placed in a manner not to disturb or damage facilities or structures, nor subject them to unbalanced loads or forces.

Flooding or jetting of sand will be prohibited where facilities or structures, in the opinion of the Engineer, might be damaged, or adjacent materials softened, by the applied water.

#### 108.09 RESTORING PAVEMENTS AND RELATED IMPROVEMENTS.

--All pavements and related improvements, such as sidewalk, curb, gutter, and side sewer vents and traps, destroyed, disturbed, damaged, undermined or removed by the Contractor, or as a result of his operations, shall be satisfactorily reconstructed or replaced by him, in accordance with the applicable requirements therefor.

Asphalt-topped pavement shall be replaced with 6-inch thick concrete base and 2-inch thick asphalt concrete wearing surface, in accordance with the applicable requirements therefor, regardless of the type of existing base or the width of trench excavation. ~~Asphalt concrete wearing surface so used shall be Type "A".~~

Where curbs, gutters, and sidewalks are replaced, junctions with the existing improvement shall be made along straight lines, at regular slab or rectangle markings, or at construction joints, as the case may be.

Construction of conform joints in asphalt pavement, and procedure relative to cutting concrete pavement, shall be in accordance with the requirements of Sections 220.09 and 201.02, respectively.

108.10 ADJUSTMENT OF MANHOLE FRAMES AND OTHER CASTINGS. --The Contractor shall set and reset, as applicable, frames and castings of governmental utility structures, including manholes, catchbasins, curb inlets, vaults, handholes and monuments, in accordance with the requirements of Section 202. Such resetting shall include the extending or shortening of the cones, barrels or risers of such structures to adjust the castings to the final pavement elevation.

#### 108.11 DISPOSAL OF MATERIALS

General. --No material shall be placed on private or public property without proper authority.

The Contractor shall not allow any portion of any refuse, excavated material, surplus concrete or mortar, or any washings therefrom, to be disposed of upon paved streets, into catchbasins or otherwise into the City Sewer System.

Burning at the site is prohibited.

Excavated Materials. --All excavated materials not suitable for backfilling or constructing embankment, and all surplus excavated materials, shall be removed from the site by the Contractor as his property.

Removed Equipment and Materials. --The Contractor shall remove from the site as his property all removed equipment, appurtenances

and other materials not specified to be reused in the work or to be salvaged as the property of the City.

Waste Materials Subject to Regulatory Control.—The Contractor's attention is directed to Article 17 of the Public Works Code (Part II, Chapter X, of the San Francisco Municipal Code) relating to regulatory control of dumps disposing of waste material derived from the construction or demolition of buildings or from any other source.

The Contractor shall comply with said Article 17, and in particular shall not dispose of any waste material within the City and County of San Francisco in a dump which does not operate under a conditional use permit as required to be issued under said Ordinance.

"Waste material", as defined in Section 850 of Article 17, means non-putrescible debris and waste materials from any source, that are combustible in nature in whole or in part, and materials including wood, brick, plaster, glass, cement, plastics and ferrous or metallic materials derived from the construction or the partial or total demolition of buildings.

#### 108.12 DELIVERY OF SALVAGED MATERIALS TO CITY YARD.

—All castings, equipment and other materials removed from existing improvements, which, in the opinion of the Engineer, have salvage value, but which are not to be reused in the work, shall be salvaged and delivered to designated City Yards or other locations within the City and there placed where and as directed, all by the Contractor at his expense. The Contractor shall remove from the site as his property all salvaged material not to be delivered as specified hereinbefore.

All patterns especially made under the contract shall be the property of the City, and after use shall be delivered to the designated City Yard, together with any patterns borrowed from the City.

Final acceptance of the work will not be recommended by the Engineer before submission to him by the Contractor of the receipts issued upon delivery of such castings, other materials, or patterns.

108.13 CONTRACTOR TO FURNISH PAVEMENT MARKING MATERIALS.—The Contractor shall furnish to the Engineer, at the site immediately prior to the start of work, suitable brushes, yellow traffic lacquer and thinner, for pavement marking by the Engineer of survey points and other references and instructions.

108.14 SAFETY REQUIREMENTS.—The Contractor shall do whatever work is necessary to adequately safeguard the public and the personnel employed at the site by taking all necessary, or required, precautions to prevent loss of life and personal injury, and he shall conduct his operations with a proper regard for the convenience of the public.

All work, equipment, and materials, including the installation thereof, shall be in full accordance with the requirements of the National Board of Fire Underwriters, the State Fire Marshal, City and State laws, the Safety Orders issued by the State of California Division of

Industrial Safety embodied in the California Administrative Code, Title 8, and any other prevailing codes and regulations pertinent to adequate protective measures and the prevention of hazardous conditions.

The performance of all work and all completed construction, particularly with respect to ladders, platforms, structure openings, scaffolding, shoring, lagging, and the like, shall be in accordance with the Safety Orders issued by the Division of Industrial Safety.

During construction, the Contractor shall construct and maintain satisfactory and substantial temporary chain link fencing, solid fencing or railing, as applicable, at all hazardous openings.

108.15 ILLUMINATION OF WORK. --When any work is performed at night, or in a tunnel or in any other place where daylight is shut off or obscured, the Contractor shall at his own expense provide artificial illumination sufficient for the proper conduct and thorough inspection of the work.

108.16 WATCHMEN. --The Contractor, where necessary to safeguard the work, shall employ a watchman or watchmen, physically capable of adequately patrolling the whole of the work, who shall be at the site of the work at all times, except during ordinary working hours, from the beginning to the date of acceptance of the work.

108.17 EQUIPMENT TO BE PUT IN OPERATION AND FAILURE OR FAULTY PERFORMANCE THEREOF CORRECTED. --Before acceptance of the work, the Contractor shall put the mechanical and electrical systems and all related equipment and appurtenances installed, relocated, modified or repaired, as the case may be, to the extent of the work actually performed under the contract, in satisfactory operation. He shall do all testing, timing, adjusting and other operations necessary to insure proper functioning of such systems and equipment in all respects in the manner contemplated.

Final adjustment of equipment shall be as determined in the field by the Engineer.

Failure or faulty performance of any equipment, furnished, installed, relocated, modified, or repaired, as the case may be, under the contract, will be considered "defects in the work" as specified in Section 105.10.

The Contractor shall furnish all labor, materials, equipment and tools, and shall defray all other expenses in connection therewith, to satisfactorily repair or replace, as necessary, as determined by the Engineer, all equipment, auxiliaries and appurtenances, to the extent of the hereinbefore defined responsibility therefor, that have failed or have performed in a faulty manner, and shall thereupon put such equipment and appurtenances into satisfactory operation.

108.18 MAINTENANCE OF SITE, PREVENTION OF DUST NUISANCE, AND FINAL CLEANUP. --The Contractor shall at all times maintain the site of the work, including field offices and construction

sheds, in an orderly and satisfactorily neat and clean condition, and shall at suitable intervals remove therefrom as his property all accumulations of rubbish or refuse material, surplus concrete, mortar, and excavated materials not required or suitable for backfill, and shall not dump any portion thereof, or any washings from concrete mixers or mixing boxes, upon paved streets, into catchbasins or otherwise into the City sewer system.

In order to protect the public from dust nuisance and property from dust damage, the Contractor shall keep the entire site of the work, inclusive of vehicular and pedestrian traffic routes through the work, continuously free of dirt and dust by adequate periodic blading, power brooming, watering or other approved means.

The Contractor may store materials and equipment in available space at the site, at locations that will not interfere with the normal use of the area, as determined by the Engineer.

Those parts of public streets, ways and sidewalks that are occupied by the Contractor shall be immediately vacated by him and returned to public use when his use thereof is no longer necessary for the prosecution of the work.

Upon completion and before final acceptance of the work, the Contractor shall remove all rubbish, surplus or discarded material, falsework, forms, temporary structures, signs not a part of the work, and all his equipment and machinery, and shall leave the entire site in a satisfactorily neat and clean condition. Buildings constructed, altered, or worked in by him shall be left "broom clean," and he shall remove all stains and other blemishes resulting from his operations, such as dropped or splattered plaster and paint, from floors, walls, ceilings, windows, finished brickwork and all other exposed surfaces.

108.19 OTHER EXAMPLES OF INCIDENTAL WORK. --For the guidance of the Contractor and to avoid unwarranted claims for extras, examples of other Incidental Work, in addition to the examples set forth in the preceding decimally numbered Sections, are given hereinafter, and it is understood and agreed that, no complete enumeration of such work being possible due to the diversity thereof, the omission of any such work herefrom is inadvertent and no ground for any claim that such work is other than incidental and included in the price bid. Typical examples of such Incidental Work are the following: all work pursuant to orders, regulations, resolutions, ordinances and laws of Governmental bodies having jurisdiction; provision of necessary shop or detail drawings, samples and test specimens; provision of equipment for, and the making of, tests; traffic routing; providing project signs; clearing, grubbing and site preparation; grading and common excavation; removing and abandoning existing sewers; maintaining sewer service; connecting sewers; removing existing brick bulkheads from sewers; constructing sand bed for pipe sewers and other facilities; furnishing and placing drains, crushed rock and filter materials; removing and replacing unsound subgrade materials within the specified limits; cutting; patching; altering existing conduits; steel work; concrete work; providing admixtures for concrete; masonry work; con-

structing embankment; compacting; providing redwood headers; galvanizing; painting; restoring landscaping; furnishing water and electrical power necessary for the conduct of operations under the contract; and furnishing and installing all materials, including appurtenances such as anchor bolts, bracing, brackets, hangers, clamps, inserts, gaskets, etc., not specified nor shown on the plans but necessary, or required, to satisfactorily complete the contract work.

## Section 109

### Traffic Routing Work

**109.01 GENERAL.**—The Contractor shall provide for the safe and proper routing of vehicular and pedestrian traffic in a manner that will minimize congestion and delay thereof. He shall furnish, install and maintain all temporary signs, lights, flares, barricades, cones, guard rail, runways, pavement, bridges, stairs, and other devices and facilities necessary to safeguard the general public and the work. Such devices and facilities shall be relocated as necessary to accomplish the proper routing of traffic as the work progresses and, upon conclusion of the need therefor, shall be removed from the site of the work as the Contractor's property.

The Contractor shall conduct his operations with proper regard for the convenience of the public and shall not unnecessarily obstruct any public street, way, sidewalk, or access to properties.

**109.02 MAINTENANCE OF TRAFFIC.**—The Contractor shall cause the least possible interference with traffic. He shall not obstruct nor close any roadway to vehicular or pedestrian traffic, except in the immediate vicinity of the work, and then only to the extent allowed by Article II, Chapter XI (Traffic Code), Part II of the San Francisco Municipal Code and any Department Orders adopted pursuant thereto by the Director of Public Works.

The Contractor shall not store, stockpile or place on any public street, way or sidewalk any equipment, materials or supplies without first obtaining the authorization of the Engineer and then only within such limits as the Engineer may designate.

Those parts of public streets, ways and sidewalks that are occupied by the Contractor shall be immediately vacated by him and returned to public use when his use thereof is no longer necessary for the prosecution of the work.

The Contractor shall not impede, at any time, free access for vehicles and pedestrians to warehouses, stores, service stations, dwellings, garages and other properties in the vicinity of the work and on adjacent streets, including those properties fronting on streets allowed or stipulated by the Special Provisions to be closed to through vehicular traffic. He shall provide for such local access by phasing his operations.

bridging, or employing other approved means; however, he may make special mutual arrangements with occupants for any temporary impediment of such access. Before initiating any such street closure, the Contractor shall notify each affected occupant at least two (2) days in advance thereof and shall supply the Engineer with satisfactory evidence that such notification was given. The closing of any street shall not prevent nor impede access by emergency vehicles, including those of the Fire Department, Emergency Hospital, and the Police Department.

Access to fire hydrants, to assure their immediate and unhampered use at all times, shall not be impaired by the Contractor. No debris, materials or equipment shall be placed within 10 feet of any fire hydrant.

The Contractor shall not block the movement of pedestrian traffic. Where necessary, the Contractor shall provide for such movement by phasing his operations, providing 4-foot wide temporary bridges across the trenches, or establishing 4-foot wide passageways in the sidewalk or street area, as applicable. Each bridge or passageway shall be bordered with safe and adequate railings or barricades, which shall be adequately lighted at night, and which shall remain in place until all work at the particular location has been completed and the sidewalk, walk, or crosswalk has been opened to the safe transit of pedestrian traffic. On barricades which direct pedestrians around the site of the work or to crosswalks not closed, the Contractor shall post, where directed by the Engineer, "NO PED CROSSING USE CROSSWALK" Code R49 signs with appropriate directional arrows. Railings or barricades which border passageways located in roadway areas shall be adequately reflectorized on the side facing oncoming traffic.

In the downtown area of San Francisco bounded by Market, Taylor, Pine, Front, Fremont, Howard, and Eighth Streets, including these boundary streets proper, no street or sidewalk excavating or opening will be allowed, except for emergency work, on the day after Thanksgiving, and during the period from December 1 to January 1, inclusive. In all other commercial districts, of one or more blocks in length, the same restriction will apply from December 15 to January 1, inclusive.

109.03 DIVERTING OF VEHICULAR TRAFFIC.—When it becomes necessary to close one or more lanes to vehicular traffic or to otherwise divert such traffic from its normal paths, the Contractor shall clearly delineate temporary centerlines separating two-way traffic, and dividing lines for other temporary traffic lanes, by employing cones, barricades, flags, reflectors, or other approved methods or devices. Placing of devices shall commence sufficiently in advance of the obstruction or other cause of the diverting of traffic to minimize congestion and shall enable traffic to enter, traverse and leave the site of the work without abrupt or unwarranted changes in direction. The Contractor shall not place devices in the roadway until the Engineer has approved the type of device and its location. Unless otherwise specified or approved, each temporary traffic lane shall be not less than 10 feet wide.

High rise warning flag units, each displaying three flags mounted at

a height of 9 feet, to provide advance warning for traffic approaching the work, will be required in all cases where motorists' visibility of the work is limited or obscured, as determined by the Engineer.

109.04 BRIDGING OVER TRENCHES AND EXCAVATIONS AND PHASING OF OPERATIONS. --The Contractor shall, by constructing temporary bridges across excavations, by phasing his operations, or by employing a combination of these two methods, provide and maintain safe and adequate passage for vehicular and pedestrian traffic over and adjacent to trenches and other excavations and provide and maintain the number of traffic lanes specified.

Bridges for vehicular traffic shall be installed, where necessary, across trenches and excavations or other work on public streets, at street crossings, and at entrances to residential, commercial, or industrial property, access to which is to be maintained. Each bridge installed on a public street shall be at least two feet wider than the total minimum width of the traffic lanes accommodated on the bridge.

All bridges for vehicular use shall be adequate for AASHO H-20 loading and shall be constructed with approved metal plates, or timber planking not less than 3 inches thick. Bridges shall be constructed with wheel guards and railings where necessary for safety.

In order to provide smooth transit over timber bridges, they shall be satisfactorily beveled at the ends, or shall be constructed flush with the roadway by recessing the pavement and lagging. "Satisfactorily beveled" shall mean that the change in elevation between the wearing surface of the street and the top surface of the said 3-inch timber planking shall occur in a distance of not less than  $4\frac{1}{2}$  feet. This beveling may be accomplished by means of temporary pavement. A bridge "flush with the roadway" is defined as one whose surface is not more than  $\frac{3}{4}$  of an inch above or below the surface of the existing pavement.

Phasing of construction of any reinforced concrete structure shall have the prior approval of the Engineer; further, any required sequence of construction shown on the plans or specified in the Special Provisions shall take precedence over such phasing of construction.

109.05 PAVING OVER BACKFILLED TRENCHES AND EXCAVATIONS. --Vehicular travel over backfilled but unpaved and unbridged trenches and other excavations will not be permitted. The Contractor shall construct, before use of pavement by vehicular traffic, and thereafter satisfactorily maintain, a smooth, regular, temporary wearing surface, not less than  $1\frac{1}{2}$  inches thick, over backfilled areas for the safe passage of vehicular traffic. All excess materials shall, at the same time, be removed and the street cleaned. The temporary wearing surface shall be in accordance with the requirements of Section 219.

When pavement is broken prior to trench excavation in a lane to be left open to traffic, the excavation of such trench must proceed within forty-eight (48) hours from the time the pavement is broken. If the preceding condition cannot be met, the broken pavement fragments must be removed and replaced with temporary wearing surface in accordance with the requirements of Section 219.

Temporary pavement shall be constructed as Incidental Work except that if the contract includes a Bid Item for temporary pavement, then all temporary pavement necessary pursuant to the requirements of traffic routing work shall be constructed only with prior approval of the Engineer, and shall be in accordance with, and will be paid for under, such Bid Item for temporary pavement.

The Contractor shall restore each section of permanent pavement and each flag of sidewalk as soon as practicable following the completion of the work for which that section of pavement or flag of sidewalk was removed.

109.06 PROHIBITION OF STOPPING AND PARKING.--The Contractor shall prohibit stopping of vehicles where and when necessary to provide the required temporary traffic lanes. The Contractor shall prohibit parking where and when necessary to keep project, loading, and storage areas clear.

Prohibition of stopping or parking will require the approval of the San Francisco Police Department. The contractor shall, in this regard, contact the San Francisco Police Department Traffic Bureau forty-eight (48) hours in advance of the start of the work. After approval of the stopping or parking restriction, the Contractor shall furnish and place approved "NO STOPPING" or "NO PARKING" signs where directed.

So that the stopping or parking prohibition will be effective and enforceable, the messages on the signs shall include the dates and times of the required prohibition. Printed overlays on the signs may be used for this purpose. Article 22,652 of the California State Vehicle Code requires a sign to be in place twenty-four (24) hours before it becomes legally enforceable.

109.07 MASS TRANSIT VEHICLES.--The Contractor shall not interrupt or otherwise interfere at any time with the passenger transportation service of mass transit vehicles such as streetcars, cable cars, busses and trolley coaches. Unless specifically stipulated in the Special Provisions, no detouring of mass transit vehicles will be permitted.

The Contractor is reminded that all mass transit facilities constitute non-governmental utility facilities as set forth in Section 104. Any additional construction, necessitated solely for the purpose of accommodating the passenger transportation service of mass transit vehicles, shall be done in accordance with the provisions of such Section 104.

However, temporary lanes made available for vehicular traffic by the Contractor shall be located so as to include an adequate travel path for trolley coach lines and Section 104 shall not apply, provided no additional construction is required. In order to accomplish the foregoing, the Contractor shall familiarize himself with the routes of all coach lines that operate within the limits of the work. The extreme touring range of the center line of a trolley coach is 10 feet from the center line of the trolley wires.

If construction necessitates temporary relocation of trolley wires or other work by the Municipal Railway, the Contractor, before starting

any work in the affected street, shall notify the Engineer and the General Manager, Municipal Railway, in writing, at least five (5) days in advance of the date he intends to start such work, so that the proper arrangements for operation of trolley coaches can be made.

109.08 EXISTING TRAFFIC SIGNAL SHUTDOWN. --Where it is necessary to shut down existing traffic signals at any intersection, the Contractor shall notify the Engineer and the San Francisco Police Department Traffic Bureau twenty-four (24) hours in advance of the start of each such shutdown, so that arrangements may be made to have a police officer on duty to control traffic.

In the event that the Police Department cannot assign an officer to the intersection, the Contractor shall, with the approval of the Engineer, place the signals on flashing operation for the duration of the shutdown. If flashing operation is not possible, the Contractor at no charge shall borrow a portable flashing unit from the Department of Electricity, 901 Rankin Street, San Francisco, and shall, in addition, make all necessary, or required, connections to effect flashing operation.

The operation of such existing traffic signals shall not be disturbed before 9:00 a.m., and shall be returned to normal operation before 4:00 p.m. of the same day.

109.09 WORK AROUND PARKING METERS. --The Contractor shall notify the Engineer at least two (2) working days before starting any work that may result in damage to parking meters, so that arrangements may be made by the City to have the meters removed at no cost to the Contractor.

Parking meters and parking meter standards damaged or loosened by the Contractor's operations will be repaired or replaced as necessary by the City; however, all expenses in connection therewith shall be borne by the Contractor.

109.10 TEMPORARY CONSTRUCTION AND TRAFFIC SIGNS, LIGHTS AND DEVICES. --Temporary signs, lights and devices shall be in accordance with the California State Division of Highways "Manual of Warning Signs, Lights and Devices for Use in Performance of Work Upon Highways." During the hours of darkness, approved lights or flares shall be maintained in sufficient numbers, in proper working order, and in proper locations to adequately illuminate the area and alert approaching traffic.

The Contractor, before starting any work which will affect the normal flow of traffic, shall furnish, install where and as necessary, or directed, and maintain, temporary signs, mounted on barricades or other suitable supports as necessary, which shall include a sufficient number of Code W21R reflector signs placed in conspicuous locations to adequately warn approaching traffic wherever it may be diverted from its normal path. The aforementioned code number and any code numbers referred to herein or indicated in the Special Provisions are those of the "Uniform Sign Chart" adopted by the California State Sign Committee and prepared by the California State Automobile Associa-

tion. Code numbers with an appended "R" indicate that signs shall be reflectorized.

Barricades shall be furnished and maintained by the Contractor along and around all work in contact with traffic, and shall not be removed until the roadway is ready for use. The barricades shall be adequately illuminated at night by kerosene flares, or other approved means.

Traffic cones shall be at least 18 inches in height and, when used to delineate traffic lanes or separate opposing traffic movements, shall be spaced at not greater than 25-foot intervals.

All signs and equipment shall be installed where and as directed. Signs and equipment in addition to those indicated hereinbefore shall be as described in the Special Provisions. Signs for use at night shall be reflectorized.

All temporary construction and traffic signs, lights, devices, barricades and cones, upon completion of the need therefor, shall be removed from the site by the Contractor as his property, unless otherwise specified.

**109.11 RELOCATION AND REMOVAL OF EXISTING PERMANENT TRAFFIC CONTROL AND OTHER SIGNS.**—On projects such as re-channelization and street widening work, or where a surplus of signs will result, the Contractor shall either relocate or remove existing permanent traffic control and other signs and standards where and as specifically shown on the plans, or where directed by the Engineer.

For all existing permanent traffic control signs which are to be removed and not relocated, the Contractor shall remove the wood standards and foundations from the site as his property. He shall load, haul and deliver the signs, and any metal standards therefor, to the California State Automobile Association's Warehouse at 55 Duboce Avenue, San Francisco, and there place them where directed. Metal standards shall be salvaged in their entirety and any concrete shall be removed from the standards by the Contractor.

The Contractor shall temporarily relocate any existing permanent traffic control or street name signs which will interfere with new traffic signal or street lighting installations, and shall notify the Engineer immediately after the installation of all traffic signal standards on their foundations, so that arrangements may be made by the City to have the signs relocated by others to new permanent locations at no cost to the Contractor.

The temporary relocation of each "STOP" or other traffic regulatory sign shall be done immediately upon its removal, and to a location as close as possible to the original position of such sign, or as directed by the Engineer.

**109.12 FLAGMEN.**—In order to avoid danger and delay to the public, the Contractor shall, during the entire time of any approved temporary use by him of any part of the roadway specified to remain open for traffic, provide competent flagmen, whose sole duty shall be to direct and control the movement of traffic through or past the work, as applicable.

109.13 CONTRACTOR TO TAKE ADDITIONAL PRECAUTIONS AND DO OTHER WORK AS NECESSARY. --The requirements set forth hereinbefore shall not necessarily be all the precautions the Contractor shall take nor all the work he shall do, to properly protect the public and the work, and they shall in no way relieve the Contractor from taking additional precautions and doing other work as necessary for such protection. Such additional precautions and other work shall in any case be done as Incidental Work.

109.14 PAYMENT. --Traffic routing work shall be done as Incidental Work and payment therefor shall be included in the price or prices bid, except that if the Proposal includes a Bid Item for traffic routing work, such work will be paid for at the lump sum price bid therefor.

## Section 110

### Measurement

110.01 GENERAL. --In addition to the general requirements hereunder, Bidders are directed to the more specific requirements in the individual Sections of these Standard Specifications covering the methods of measuring and paying for particular materials and types of work.

Except where payment for the work is made at the lump sum price or prices bid therefor, payment shall be based on measurements of the completed work in accordance with, and by instruments and devices calibrated to, United States Standard Measures, and the units of measurement for payment, and the limits thereof, shall be as shown on the plans or specified in the Special Provisions, or in the absence thereof, as set forth in these Standard Specifications. The Engineer will make the measurements at no cost to the Contractor except as otherwise specified.

In estimating progressive payments and final quantities, all lengths and areas shall be based on horizontal measurements, unless otherwise specified. The polar planimeter may be used for measurement of areas in estimating quantities under the contract.

Volumes of excavation and embankment, unless otherwise specified, shall be computed by the method of average end areas and appropriate horizontal distances.

110.02 WEIGHT MEASUREMENTS. --Material paid for by the ton, if local material or material not shipped by rail, shall be weighed on platform scales furnished by the Contractor, or on public scales at the expense of the Contractor. A ton shall consist of 2,000 pounds avoirdupois. The platform scales shall be of sufficient size and capacity to concurrently weigh the load and the vehicle carrying the load. The Contractor shall furnish the Engineer with a Certificate of Inspection from

the Sealer of Weights and Measures of the County having jurisdiction, or from the Bureau of Weights and Measures of the State of California, attesting to the accuracy of the scales furnished by him; and further, he shall furnish additional certificates as often as the Engineer may deem necessary to assure the continued accuracy of the scales; all at no cost to the City.

If the Contractor elects to use public scales they shall bear a current valid seal of approval of the Sealer of Weights and Measures.

Whenever material is weighed on scales used for any commercial purpose, the scales shall be operated by a weighmaster licensed in accordance with the provisions of Division 5, Chapter 7 of the California Business and Professions Code. The Contractor shall furnish a Public Weighmaster's certificate, or a Private Weighmaster's certificate, or certified daily summary weigh sheets. A representative of the City may, at the discretion of the Engineer, be present to witness the weighing and to check and compile the daily record of such scale weights.

The City reserves the right to require that no weighing shall be done on scales furnished by the Contractor or on public scales except in the presence of an authorized representative of the Engineer and further reserves the right to check the tare weight of each truck used to haul materials paid for by weight at any time specified by the Engineer.

110.03 TRUCK MEASUREMENTS. -- Material specified to be measured by "Truck Measurement" or similar designation indicating that the material shall be measured by volume in the transporting vehicles, shall be hauled in approved vehicles of such type that the actual cubic contents can be readily and accurately determined. Such vehicles shall be made available to the Engineer for the purpose of measurement prior to use. The water level volume of each truck body, to the top of side-boards, shall be determined by actual measurements checked and approved by the Engineer. Unless all such approved vehicles are of uniform capacity, each shall bear a plainly legible identification mark indicating the specific approved capacity.

All vehicles shall be loaded to at least the approved capacity. In the event of a controversy, and when requested by the Engineer, all loads under dispute shall be struck off to a level surface at the point of delivery.

Loads will be tallied by truck numbers and respective truck capacities, on the site of work by the Engineer. All trucks shall be tallied and inspected before being dumped, and shall be dumped where directed.

110.04 MISCELLANEOUS MEASUREMENTS. -- When concrete is specified in the Special Provisions to be paid for by volume, the volume shall be the actual volume within the neat lines of the structure shown on the plans. A deduction of one cubic foot of concrete will be made for each linear foot of piling, other than sheet piling, projecting into the concrete. No deduction will be made on account of the displacement of concrete by reinforcing steel, by structural steel shapes used in encasement work, by dowels, or, unless otherwise specified in the Special Provisions, by conduits, raceways or ducts.

When lumber and timber are specified in the Special Provisions to be paid for on the basis of the quantity of lumber and timber incorporated into a structure, payment will be made at the price bid per thousand feet, board measure (M.F.B.M.), based on nominal sizes and actual lengths, for the actual quantity satisfactorily incorporated into the structure. No payment will be made for lumber and timber wasted and not actually so incorporated.

When steel, cast iron or other metals, or metal products, are specified in the Special Provisions to be paid for by weight, the weighing thereof shall be done on shop scales in the presence of the Engineer or his authorized representative. Payment will be made at the price bid per pound.

If so specified in the Special Provisions, the weight shall be computed from dimensions shown on the plans or approved shop drawings, without deductions for rivet or open bolt holes. No allowance shall be included for weld metal, but an additional allowance for full weight of rivets before driving shall be included. The number of rivets so included shall be the exact number required for construction without excess to cover loss or waste. Weight of bolts actually left in place after construction shall be included, but no allowance shall be made for erection bolts.

## Section 111

### Changes and Extras

111.01 GENERAL.—In accordance with the provisions of Section 101.06, the Director, before the date of acceptance of the work, may in writing order alterations in the kind, amount, dimensions, or alignment of all or any part of the work, or may order the performance of additional work, and any such order shall be carried out by the Contractor in accordance with the intent of the specifications.

The Contractor shall, before putting any such order into effect, and in accordance with the provisions of Section 97 of the Charter, agree in writing with the City upon the adjustment to be made in the contract cost in consideration for the execution of such order.

When such order pertains to work of a class or classes for which unit prices are established in the contract, then such adjustment shall be made strictly in accordance with such unit price or prices.

When such order pertains to work of a class or classes for which no such unit prices are so established, then the agreed adjustment shall either be based on unit prices determined upon fair and equitable grounds, or shall be a lump sum similarly determined, or such adjustment shall be made as provided hereinafter.

When such order pertains to work of a class or classes for which no such unit prices are so established and, when due to uncertain conditions to be encountered in the work or for any other cause, no agree-

ment can be reached upon appropriate unit prices or lump sum adjustment, then the work shall be done by force account and the adjustment to be made in the contract cost shall be determined as provided in Section 111.02.

No allowance will be made for anticipated profits in determining any adjustment to the contract cost due to any alteration in the amount of work performed under the contract.

Any agreement made pursuant to the provisions of this Section shall be a part of the contract and subject to all conditions thereof as they apply.

#### 111.02 FORCE ACCOUNT

General. - The amount to be paid to the Contractor for work done under force account shall be the sum of the component cost of such work, directly chargeable thereto, as defined hereunder in the numbered paragraphs 1) to 7), inclusive, and subject to the following provisions:

For force account work done by the Contractor, the amount to be paid shall be the sum of the costs and amounts determined as set forth hereunder in numbered paragraphs 1) to 7), inclusive.

For force account work done by a subcontractor, the amount to be paid to the Contractor shall be the sum of the costs and amounts determined as set forth hereunder in numbered paragraphs 1) to 7), inclusive, plus 5 percent thereof.

The amount paid to the Contractor as provided in the preceding paragraphs shall be understood to include full compensation for any and all expenses incurred by the Contractor and his subcontractors in connection with the force account work.

The aforementioned component costs shall be as follows:

- 1) The cost of labor, including foremen, for the time actually engaged on the force account work.
- 2) The cost of materials furnished, other than those, if any, furnished by the City, incorporated into, or necessarily used in the prosecution of, the force account work, less the salvage value of any materials salvaged upon completion of such work.
- 3) An amount equal to a percentage of the costs determined as set forth above under numbered paragraphs 1) and 2), which amount shall be considered full compensation for profit, tools, plant, depreciation, overhead, superintendence, and the costs of the bond for faithful performance and of the bond for materials and labor. The percentages shall be as follows:

For the cost determined as set forth under the hereinbefore numbered paragraph 1), the percentage shall be 20; and the percentage for costs under 2) hereinbefore shall be 15.

- 4) The cost of the use of equipment on the force account work, calculated at the current California Division of Highways equipment rental rate schedule, plus 15 percent thereof, if the equipment is owned by the Contractor or a subcontractor. If the equipment is rented, the cost thereof shall be based on actual rental invoices and an amount equal to 5 percent of the rental cost shall be added, which amount shall be considered full compensation for car-

rying charges and all other related costs. Equipment used on force account work shall be of the proper size and type. If, however, equipment of unwarranted size or type and cost is used, the cost of the use of such equipment shall be calculated at the rental rate for equipment of the proper size and type.

- 5) The amounts paid in compliance with the United States Social Security Act and the State of California Unemployment Reserves Commission Act, in compliance with Employee Welfare provisions of legal employee-management contracts, and for Workmen's Compensation Insurance.
- 6) The amounts paid for specified, or approved, Public Liability and Property Damage Insurance, and for other specified, or approved, insurance.
- 7) The amounts paid in compliance with the State of California Retail Sales Act and the State of California Use Tax Act and City and County of San Francisco Sales Tax.

City May Furnish Materials. --The City reserves the right to furnish such materials as it may deem expedient, and no allowance will be made for profit thereon.

Recording, Billing, and Certifying of Charges. --All force account charges shall be recorded daily upon report sheets prepared by the Engineer, furnished to the Contractor, and signed by both parties, which daily reports shall thereafter be considered the true record of the force account work done. All bills for force account work shall be presented monthly at the time progress estimates are being made, and shall be accompanied by the original receipted bills for materials, equipment rental, and copies of payrolls bearing the Contractor's signed certificate of the truth and accuracy of such copies.

## Section 112

### Payment

112.01 GENERAL. --The Contractor shall accept the compensation provided in the contract as full payment for furnishing all labor, materials, equipment and tools necessary, or required, to satisfactorily complete all work, including all Incidental Work, contemplated and embraced under the contract; also for loss or damage arising from the nature of the work, or from the action of the elements, or from any unforeseen difficulties which may be encountered during the prosecution of the work until the acceptance by the Director and for all risks of every description connected with the prosecution of the work, also for all expenses incurred in consequence of the suspension or discontinuance of the work as provided in the contract. Neither the payment of any estimate nor of any retained percentage shall relieve the Contractor of any obligation to make good any defective work or material.

No compensation will be made in any case for loss of anticipated profits.

It is understood and agreed that the standard method, unit, or measurement, for payment set forth in these Standard Specifications may be modified or superseded in the Special Provisions which shall prevail.

If certain necessary or required work, normally considered to be unit Bid Items, are not listed in the Schedule of Bid Prices, such work shall be done as Incidental Work or included for payment in the lump sum price bid, as applicable.

112.02 PROGRESS ESTIMATES BY ENGINEER. --In order to assist the Contractor to prosecute the work advantageously, the Engineer shall or or about the last day of each month, make an estimate of the value of the work done and materials incorporated into the work by the Contractor.

These estimates shall be of the value of the labor done and materials incorporated into the work since the Contractor commenced the performance of the contract. Such estimates need not be made by strict measurements, but may be approximate only, and shall be based upon the whole amount of money that will become due according to the terms of the contract when the whole of the work shall have been completed.

In estimating progressive payments, the Engineer may use the unit prices bid by the Contractor in his proposal. In case the said unit prices do not represent, in accordance with the provisions of Section 96 of the Charter, the actual value of the work, labor and materials furnished, the Engineer may estimate progressive payments based on prices reflecting such actual value. Unless modified in the Special Provisions, no allowance will be made in these estimates for materials or equipment delivered at or near the site of the work but not incorporated into the work.

112.03 PROGRESSIVE PAYMENTS. --Upon completion of each progress estimate made by the Engineer as set forth in the immediately preceding Section, the City will, subject to the provisions of Section 112.04 or as otherwise specified in the Special Provisions, pay or cause to be paid to the Contractor in the manner provided by law, a progressive payment. Such payment will be in an amount equal to 90 percent of the Engineer's estimate, or such other amount as may be specified in the Special Provisions, less previous payments made.

All estimates and payments made under the provisions of the Section shall be subject to correction in any subsequent estimate and payment. Under no circumstances shall the making of a progressive payment be construed as an acceptance of any of the work under the contract.

112.04 PAYMENT MAY BE WITHHELD. --Payments may be withheld at any time if the work is not proceeding in accordance with the contract, or if, in the judgment of the Engineer, the Contractor is not complying with the requirements of the contract and specifications.

112.05 FINAL INSPECTION, ACCEPTANCE AND FINAL PAYMENT. --Upon notification by the Contractor that the work is completed and ready for final inspection, the Engineer will make such inspection.

As soon as all necessary measurements and computations have been made, the Engineer will prepare the final estimate of the total value of the work done in accordance with the terms of the contract. The amount of the final estimate shall be the contract cost adjusted as provided in Section 111.

If the Engineer finds, after final inspection, that the work covered by the contract has been fully and satisfactorily completed, and upon the completion of his final estimate, and if such estimate is agreeable to the Contractor, the Engineer will so notify the Director, and recommend the acceptance of the work and final payment of the entire balance due the Contractor.

The issuance by the Director of the Order of the Department of Public Works accepting the work, and the receipt of a copy of such order of acceptance in writing, shall be authority for the Controller of the City and County of San Francisco to complete any payment due the Contractor under the contract.

Acceptance of the work as provided hereinbefore, however, may be withheld if the final estimate made by the Engineer is not agreeable to the Contractor. In the event agreement on the final estimate cannot be reached, the Contractor shall immediately so inform the Engineer and within ten (10) days thereafter shall present his version of the final estimate and supporting calculations and data in writing to the Director. The Director will, within ten (10) days after receipt of such presentation, inform the Contractor of his decision which shall be final.

The final payment shall be the amount of the final estimate, less the sum of all progressive payments made as provided in Section 112.03 and less the amount of any sum or sums deducted in accordance with the provisions of the contract, and shall be made in the manner provided by law.

## PART II

### STREETS AND HIGHWAYS

#### Section 200

#### Clearing, Grubbing and Site Preparation

200.01 GENERAL.—The Contractor shall clear, grub, and prepare the site, as necessary or required, to accomplish the contract work where shown on the plans and in accordance with the requirements set forth herein. Areas shall be cleared and grubbed in their entirety, and such clearing and grubbing shall include removing from the site and disposing the following:

- 1) all grass, shrubs, weeds, brush, trees, branches, stumps, root systems and other vegetation, to a lower limit of 3 feet below adjacent existing ground, including all scarifying, cultivating, raking, rolling, and watering specified or shown on the plans as incident to the work under this Section;
- 2) all existing abandoned concrete or masonry building walls, footings, copings and stairs, which remain after demolition and are exposed on at least one side thereof above the level of the adjacent ground or street and sidewalk construction, to the extent of such exposure above the lowest adjacent ground or street and sidewalk construction, and all exposed concrete slabs other than existing street and sidewalk pavement, all to a lower limit of 3 feet below adjacent existing ground, street and sidewalk construction, or the required subgrade, whichever is higher; and within the limits of the work and outside the limits of existing street and sidewalk construction, all existing concrete curb and concrete and asphaltic pavement materials, including any extension thereof to a lower limit of 3 feet below the level of adjacent existing ground, or the required subgrade, whichever is higher. The Contractor shall break up or penetrate, as required, to allow normal water filtration and drainage, exposed or encountered existing slabs and walls which are to remain in place;
- 3) portions of existing chain link and board fences, including, if specified or shown on the plans, all construction necessary to properly terminate such fences;
- 4) all rubble, debris and other obstructions down to the approximate level of existing adjacent ground, sidewalk, or street pavement;
- 5) all waste and refuse.

The Contractor shall not disturb the existing trees designated in the Special Provisions to remain. The City reserves the right to remove

any trees or plants prior to clearing and grubbing operations. Existing improvements, facilities, trees, and shrubbery that are not to be removed shall be protected from destruction or damage by the Contractor's operations.

All trees removed shall be grubbed. Such grubbing shall consist of the complete removal of stumps, tap and lateral roots 1-1/2 inches or more in diameter, buried logs, and similar objectional material if encountered, to a depth of 3 feet below the existing ground surface.

All holes resulting from grubbing operations shall be filled in accordance with the requirements for backfilling to the elevation of adjacent cleared ground. Such backfill shall be compacted to not less than the density of adjoining undisturbed sound material.

If required, sod and loam which is removed shall be properly preserved and stored for use.

200.02 SOIL STERILIZATION. --The Contractor shall apply an approved soil sterilizing agent, in accordance with the requirements of Section 802.03, to areas that he has cleared and grubbed, where such clearing and grubbing involved the removal of weeds and other vegetation, or where the areas are to be landscaped, whether or not under the contract. Soil sterilization shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

200.03 RAZING EXISTING BUILDINGS. --Ordinarily, the removal of all buildings within the limits of the work, to the approximate level of adjacent cleared ground, will have been done by others at no cost to the Contractor, and clearing, grubbing and preparing the site will not include the razing or demolition of any buildings or improvements other than fence and, to the extent specified in Section 200.01, concrete and masonry foundations.

When required by the Special Provisions the Contractor shall raze the existing buildings and remove from the site of the work as his property all lumber, concrete, metal, piping, wiring, fixtures and other related improvements therefrom, including portions of existing piles that will interfere with the construction, all where and as shown on the plans or specified.

The Contractor is cautioned that there may have been changes in the existing structures during and since the time of original construction; the City therefore does not guarantee the accuracy nor completeness of any plans or information regarding such structures.

200.04 DISPOSING OF MATERIALS. --The disposal of cleared, grubbed and razed material shall be in accordance with the requirements for excavated materials set forth in Section 108.11.

200.05 PAYMENT. --Clearing, grubbing and site preparation satisfactorily done as specified will be paid for at the lump sum price bid therefor.

Razing existing buildings satisfactorily done as specified will be paid for at the lump sum price bid therefor.

If the Proposal does not contain Bid Items for such work, it shall be done as Incidental Work as set forth under Section 108.

## Section 201

### Pavement Excavation

**201.01 GENERAL.**—The Contractor shall excavate, remove, and dispose of, existing concrete curb, sidewalk, pavement and base, stone curb, asphalt concrete base and wearing surface, including the latter at conform points, cement treated rock base, and plain and reinforced concrete and masonry, walls, foundations, coping, manholes, catch-basins, and other structures, all where, as, and from within the limits shown or indicated on the plans for pavement excavation, and elsewhere where directed; shall construct compacted embankment in areas from which, as necessary to obtain the required subgrade, the hereinbefore specified materials have been removed; and shall do all other necessary or required Incidental Work.

Attention is directed to the possibility of the existence of pavements of unknown thickness, or thickness different from that shown on the plans. Payment under a pavement excavation Bid Item will be made for the actual volumes of pavement removed. Where traffic and center islands built on top of existing street pavements have pavements  $3\frac{1}{2}$  inches thick, excavation of the backfilled space above street pavement shall be done as Incidental Work.

In the absence of cross sections, information on the plans, or specific limits set forth in the Special Provisions defining lateral limits of excavation, pay quantities shall include only those volumes lying between street property lines.

Excavating that shall not be done under a Bid Item for pavement excavating is that:

- 1) of earth, untreated rock and macadam bases, asphalt paths, basalt block gutters, and cable car conduit and yoke structure;
- 2) within the limits defined for a Bid Item for excavation in a specified width of existing street railway track area;
- 3) outside of or beyond, including overbreak, the limits shown on the plans or specified to be done under a Bid Item for pavement excavating.

Materials excavated beyond the shown or specified limits, and overbreak, shall be satisfactorily replaced by the Contractor at no cost to the City.

Pavement excavation not within the limits shown or specified therefor, including that, as specified in Section 224, necessitated by other work under the contract, shall be done as Incidental Work.

Existing concrete, masonry, and pavement, necessary to be removed, to obtain the required subgrade, shall be excavated to 3 feet

below such subgrade, and the resulting voids created below subgrade shall be backfilled as Incidental Work. In areas where no improvement is to be constructed, such concrete, masonry, and pavement shall be excavated to a depth of one foot, slope measurement, beneath the face of the slope.

Abandoned pits, vaults, and basements under pavement or sidewalk areas, to the extent that the walls and slabs thereof are to remain in place, after having been broken or penetrated, as required to allow normal water filtration and drainage, shall be backfilled, as Incidental Work, with sand compacted to maximum density by watering.

201.02 CONCRETE SAW CUTTING REQUIRED. --Where the existing finished pavement surface is concrete, including concrete parking strip and concrete sidewalk, cuts therein between pavements to be removed and those to remain in place shall be made by an approved pavement cutting saw before any pavement is jackhammered or broken, and in sidewalk and traffic island pavement shall be to neat flag lines. Similarly, concrete saw cuts shall be made for the full length of the juncture of the portion of existing concrete structure or footing to remain with that to be removed.

Saw cuts shall be 2 inches deep, neat, regular, and vertical. The Contractor shall exercise extreme care not to damage the cut edges of the surface. Damaged edges shall be recut to acceptable alignment.

Where the edge of excavation closest to the curb in Portland cement concrete parking strip or pavement is less than four (4) feet from the curb, the pavement in the area of the cut shall be removed to the curb; if the parking strip in this case is monolithic with curb, removal shall be to within 6 inches of the curb.

When an edge of excavation is less than four (4) feet from a construction joint in parking strip or pavement, that portion thereof between the construction joint and the excavation shall be removed.

Cuts to the curb in concrete pavement not monolithic with adjacent curb shall be saw cut to as close to the curb as possible, and extended neatly and regularly thereto by means other than saw cutting.

Saw cuts to the curb in monolithic curb and parking strip shall be terminated as close to the curb as possible, and in the case of trench, with a saw cut parallel thereto, and the work completed by tunneling. If the cut is not for trench, extension thereof shall be as hereinbefore specified for pavement not monolithic with curb.

Ordinarily, in the case of trench excavation the Contractor shall not cut, but shall tunnel under concrete curb and combined concrete curb and gutter. If, however, it is required, or the Contractor elects, to remove a portion of curb or combined curb and gutter, he shall remove an entire section between construction joints.

All required concrete saw cutting shall be done as Incidental Work.

201.03 STONE CURB. -- All existing stone curb removed by the Contractor and not to be reused in the work, shall be delivered by him to the City's Yard on Jerrold Avenue between Phelps and Quint Streets, and there stacked where directed. The Contractor shall exercise care

in the removal of, and shall not break such curb. Stone curb hauling and stacking shall be done as Incidental Work and payment therefor shall be included in the price or prices bid. Where stone curb is to be reset or replaced, as specified in Section 210, removal thereof will not be considered pavement excavation, and the cost of removal shall be included in the price bid for such resetting or replacing.

201.04 STREET RAILWAY TRACKS.—Pavement excavation in a specified width of existing street railway track area shall include:

- 1) the excavation, by means of hand tools and hand operated pneumatic tools, of pavement materials and header blocks to the full depth of the rails in preparation for the removal and salvage, under a separate Bid Item, of street railway rails without damage thereto; and after such removal and salvage,
  - 2) the excavation of all rails and railway track materials not to be salvaged, and all pavement materials, ballast, ties and other materials, including concrete rail stringers, if any; all
- from within the limits of the specified width of track area shown on the plans, and lying within the depth specified or shown on the plans or cross sections, usually 2 feet, from and measured normal to the surface of the existing pavement.

201.05 ASPHALT CONCRETE WEARING SURFACE AT CONFORM AREAS.—The Contractor shall remove existing asphalt concrete wearing surface where and to the extent shown on the plans, or necessary as determined and specifically directed by the Engineer, to achieve a properly smooth surface at the juncture of existing asphalt concrete wearing surface to be constructed.

In areas where existing asphalt concrete wearing surface alone is to be removed, as in conform areas, such removal shall be by the use of hand or hand-operated pneumatic tools, except that with the approval of the Engineer the heater-planer may be used. However, the use of the heater-planer to remove asphaltic concrete surface at conform points will be considered Incidental Work and payment therefor shall be included in the price or prices bid for removal of the wearing surface.

Existing asphalt concrete wearing surface in the conform areas shall be removed to a depth of two inches or to the top of the pavement base whichever depth is the least.

The Contractor, at his option, may remove more than two inches of asphalt concrete wearing surface in these areas; however, such additional pavement removed will not be included in the quantity of pavement excavation for which payment will be made.

After the existing asphalt concrete wearing surface has been removed, existing concrete base found to have been patched with asphalt or defective concrete shall be removed to the extent directed.

Section 220.09 specifies operations to be performed on the same day that wearing surface is removed.

The Contractor shall not damage concrete base during and after the removal of the asphalt concrete wearing surface. The use of heavy

equipment which crushes or causes damage to the base will not be allowed. Concrete base damaged by the Contractor shall be replaced by him at his expense.

201.06 CABLE CAR CONDUIT AND YOKE STRUCTURE.--The Contractor shall excavate, remove from the site, dispose of, and construct compacted backfill in place of, all abandoned cable car conduit and yoke structures and elements and appurtenances thereof within the limits of the work, where and as shown on the plans, or where directed by the Engineer.

It is believed, although the City takes no responsibility for such belief, that cable car conduit and yoke structures are beneath, lie along and within approximately ten feet of the center line of each existing pair of rails, and that each such structure consists of a concrete or brick conduit with transverse concrete-covered steel yoke members spaced at approximately 3 to 4-foot centers along the conduit, and that the original area of cross section at the largest section thereof was approximately fifteen (15) square feet. The original cross sections may or may not have been reduced, and the voids therein may or may not have been filled with rock or sand. In any case, all required removal and construction of compacted backfill in place thereof shall be included under removal of cable car conduit and yoke structure.

201.07 DISPOSAL OF EXCAVATED MATERIALS.--The disposal of excavated materials shall be in accordance with the requirements of Section 108.11.

201.08 CITY MAY LIMIT USE OF PAVEMENT BREAKER.--In accordance with the requirement of Section 373 of the Public Works Code there shall be no limitation on the use of labor-saving devices except at the locations, if any, specified in Section 104.04 or in the Special Provisions, provided however that when, during construction operations, an additional location is revealed where, in the judgment of the Engineer, such limitation is necessary to avoid public nuisance or protect public health, safety or facilities, then the limitation shall apply to such additional location and the additional expense caused to the Contractor by the limitation on his operations in such additional location shall be estimated and paid for as Extra Work in accordance with the requirements of Section 111.

201.09 PAYMENT

General.--Pavement excavation satisfactorily done, as specified, will be paid for at the price bid per cubic yard measured in place as the aggregate net volume of pavement materials excavated from within the limits shown, specified, or directed, but not including specified exclusions.

The removal of asphalt concrete wearing surface in conform areas, if the Proposal contains a Bid Item therefor, will be paid for at the price bid per cubic yard, or if a specific Bid Item therefor

does not exist, the volume of wearing surface removed from conform area will be included for payment as pavement excavation.

Pavement excavation, if there is no Bid Item therefor, will, if specified, be included for payment as common excavation or excavation.

If the Proposal does not contain a Bid Item for any such work, it shall be done as Incidental Work as set forth under Section 108.

In Specified Width of Track Area.--Pavement excavation within a specified width of track area and depth will be paid for at the price bid per linear foot as such track area satisfactorily excavated, measured horizontally along the centerline of the tracks.

Removal of Cable Car Conduit and Yoke Structure.--Removal of cable car conduit and yoke structure will be paid for at the price bid per linear foot of conduit and structure, satisfactorily excavated, measured horizontally along the longitudinal centerline thereof.

If the Proposal does not contain a Bid Item for such work, it shall be removed as a "Subsurface Obstacle" as Incidental Work, as set forth under Section 108.05.

## Section 202

### Adjustment of Manhole Frames and Other Castings

202.01 GENERAL.--In order to insure a true, smooth pavement wearing surface, all frames and castings of manholes, catchbasins, curb inlets, vaults, valves, handholes, monuments, and other installations in the street and sidewalk area, hereinafter referred to as "castings," shall be reset accurately to the final finished pavement surface. Resetting includes extending or shortening the cones, barrels or risers of such structures as required for the proper adjustment of the castings. The work to be done by the Contractor and the "Owner," respectively, in connection with the required removal and resetting of such castings and the paving work relative thereto, shall be in accordance with the requirements hereinafter specified. The term "Owner," as used in this subsection, means an owner of utilities as defined in Section 104.

In the case of castings owned by the Department of Public Works, Department of Electricity, Police Department, Fire Department, and of the Auxiliary Water Supply System, the Contractor shall perform all necessary work in connection therewith, including the work herein specified to be performed by the Owner. All such castings shall be reset to finished pavement grade, and the subsequent repaving adjacent to the castings shall be completed, not later than 7 calendar days after the surrounding wearing surface has been constructed.

The Contractor may enter into a private agreement with the

Owner to do work that is the responsibility of the Owner, provided that such work will be done at no cost to the City. The Owner will furnish all materials for the work specified to be done by him.

202.02 CONSTRUCTION OR RECONSTRUCTION OF PAVEMENT.—Where pavement, or pavement base and wearing surface, is to be constructed, or if existing, is to be removed and reconstructed, the Contractor shall construct a box around each casting. The box shall be 5 feet square around sewer and vault manholes and proportionately dimensioned for other castings. The construction of pavement shall be temporarily omitted within the confines of the boxes. The Owner of each casting will then remove his castings, after which the Contractor shall carefully cover the openings in the exposed structures with planks not less than 2 inches thick and shall fill the boxed out areas with a temporary pavement consisting of at least 4 inches of graded rock and 1 inch of asphalt concrete wearing surface.

After the pavement surrounding the boxes has been constructed, the Owners of the castings will remove the boxes and the temporary pavement from within them and will reset the castings to conform accurately with the finished pavement surface. Resetting will be done in a workmanlike manner using Class "B" concrete, bricks set in Class "B" mortar, or rings or other approved devices.

After each casting has been satisfactorily reset to the finished pavement surface, the Owner will place Class "B" or "C" concrete in the entire boxed out area around the casting to within 1 inch of finished pavement grade, upon which he will construct asphalt concrete wearing surface to finished pavement grade. Where the surrounding pavement wearing surface is concrete, the boxed out area shall be paved with Class "B" or "C" concrete to finished pavement grade.

When it is necessary for an Owner to reconstruct a vault, and the construction of the pavement base in such area would otherwise be delayed, the Contractor shall box out the entire vault area so that he may proceed with the work. Upon completion of the reconstruction of the vault by the Owner, the Contractor shall construct temporary pavement in the boxed out vault area in accordance with the requirements for temporary pavement specified hereinafter. The Owner of the vault subsequently will remove the box and the temporary pavement, reset his vault access casting or castings to the finished pavement surface, and repave the entire vault area in accordance with the requirements specified hereinbefore.

202.03 RESURFACING - OVER AND IN PLACE OF EXISTING WEARING SURFACE.—Where resurfacing is to be done and asphalt concrete wearing surface is to be constructed over existing pavement wearing surface regardless of type, the Contractor shall construct the wearing surface continuously over all castings, except valve castings. It will be the responsibility of the Owners of the castings so covered to reference them in advance in such manner

that they may later be located readily. The Contractor may construct the wearing surface continuously over valve castings provided that he uncovers the valve castings immediately after constructing the wearing surface.

After the resurfacing has been completed, the Owner will cut through the pavement around each casting and reset the casting to conform accurately with the finished pavement surface. Resetting the castings and subsequent repaving in the cut out areas will be done by the Owner in the manner specified hereinbefore.

When castings exist in an area from which existing wearing surface is to be wholly or partially removed, the Contractor shall cut through the pavement around each casting, after which such casting will be removed by its Owner. If required by the Special Provisions, the Contractor shall then provide a satisfactory temporary riding surface over the openings as hereinbefore specified, except that the box will not be required.

After the wearing surface surrounding an opening has been constructed, the Owner will remove the temporary pavement from within the cut out area, reset the casting, and repave as hereinbefore specified.

202.04 ALTERNATIVE METHODS.—The Owners and the Contractor may agree to any modification of, or alternative to, the hereinbefore specified methods of resetting castings, provided that application for the use of such modification or alternative is made in writing to, and is approved by, the Engineer.

202.05 PAYMENT.—Work specified to be performed by the Contractor, in connection with the adjustment of manhole frames and other castings and paving occasioned thereby, shall be done as Incidental Work and payment therefor shall be included in the price or prices bid, except that:

- 1) In the cases of both Governmentally and non-Governmentally owned castings, if the basis established in the Proposal for payment for asphalt concrete leveling course or wearing surface, as the case may be, is by unit weight, all temporary and permanent asphalt concrete pavement constructed, and hereinbefore specified to be done by the Contractor, will be paid for at the unit price bid therefor; and
- 2) In the cases of Governmentally owned castings, if the basis established in the Proposal for payment for pavement elements is by unit area, each such pavement element constructed will be paid for at the unit price bid therefor.

## Section 203

### Common Excavation

203.01 GENERAL.—The Contractor shall excavate and do all Incidental work to bring the existing subgrade or ground surface, as the case may be, to the required subgrades and elevations. The work shall include:

- 1) Excavating waterbound macadam, untreated rock base, asphalt paths and basalt block gutters;
- 2) Stripping and grading existing slopes;
- 3) Removing and disposing of obstructions;
- 4) Excavating all concrete and masonry walls, slabs, structures, and pavement materials not specified to be removed under other Bid Items, all rubble and debris within the volume specified to be excavated as common excavation, and all material contained by structures and parts thereof which are to be removed as other than common excavation;
- 5) Breaking up or penetrating, as required to allow normal water filtration and drainage, exposed or encountered existing slabs and walls which are to remain in place; and
- 6) The constructing of drainage ditches necessary or required for the protection of the work;

all where, as, and within the limits shown on the plans or cross sections, or specified.

If the Proposal does not include a separate Bid Item for pavement excavation, no differentiation will be made between pavement material and other material excavated, and pavement excavation shall be included under whatever Bid Item, such as excavation, common excavation or embankment, is included in the Proposal.

In the absence of cross sections, information on the plans, or specific limits set forth in the Special Provisions defining lateral limits of excavation and embankment, pay quantities shall include only those volumes lying between street property lines.

Excavating shall not unnecessarily disturb the material below subgrade. Materials excavated beyond the shown or specified limits, and overbreak, shall be backfilled at no cost to the City.

All excavating not within the limits shown on the plans or cross sections, or specified, to be paid for under a Bid Item, including that, as specified in Section 224, necessitated by other work under the contract, shall be done as Incidental Work.

Not included in this work will be that shown or specified to be done under other Bid Items or as Incidental Work, such as the excavating and removal of grass, shrubs, trees, stumps, roots, other vegetation and fencing. No reduction, however, will be made in the pay quantity of a Bid Item for common excavation or excavation on account of excavating specified to be done under another Bid Item, such as that of those portions of concrete and masonry foundations, walls, slabs, stairs and appurtenances, and cable car conduit and

yoke structures, that intrudes into, or occurs within, the volumes specified to be excavated as common excavation or excavation.

Excavation for the purpose of obtaining borrow material shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

No reduction in the pay quantity of a volume of common excavation, or excavation, designated to be paid for under a Bid Item, will be made on account of the presence therein of any subsurface obstacle removed in accordance with the requirements of Section 203.02.

If the Proposal contains a Bid Item for earthwork, it will contain a Bid Item for either excavation or embankment whichever is estimated to exceed in quantity, and other earthwork shall be done as Incidental Work.

If the Proposal does not contain a Bid Item or Items for other work required to be done in connection with excavating, all such work shall be done as Incidental Work and payment therefor included in the price or prices bid. Such work includes, but is not limited to, the following:

- 1) Placing and compacting approved material to construct required embankment, or to fill or backfill holes, pits, depressions, and excavations resulting from the removal of subsurface obstacles, structures and other facilities, all to the elevations required to obtain the pavement subgrade or ground surface shown on the plans or cross sections. Such work done with site excavated materials shall include all loading and hauling thereof; if specified or required to be done with imported fill or designated borrow material, or crushed rock, the furnishing of the required material at the proper site location, if the Proposal contains a Bid Item therefor, will be included for payment thereunder.
- 2) All required benching, scarifying, watering or drying of materials to the required moisture content, shaping and finishing constructed subgrade as specified in Section 204, constructing and maintaining the required slopes and ditches and stockpiling and replacing topsoil.

If required in order to comply with the traffic routing or other provisions of the specifications or because of the danger of overburdening an existing or potential slide area, materials shall not be stored on the site, nor, in the latter case, on slopes above or below the site.

The Contractor, at his sole expense, shall remove materials that, on account of the nature or performance of the work, slide into, or slip from, a constructed slope or subgrade, and shall re-finish and maintain during the contract period, such slopes and subgrades to the lines and grades shown on the plans and cross sections.

Tops of slopes shall be rounded as shown on the plans. Material removed in rounding excavated slopes will be measured for payment as specified for the material removed. No payment other than the

contract unit price governing the applicable earthwork will be made by reason of field modification of slopes.

The Contractor, in accordance with the requirements of Section 108.18, shall wet down any area whenever necessary to prevent dust nuisance.

203.02 REMOVAL OF SUBSURFACE OBSTACLES.--The Contractor, as Incidental Work in accordance with the requirements of Section 108.05, shall remove to the limits specified, all subsurface obstacles necessary to be removed or partially removed to obtain the required subgrade.

Subsurface obstacles shall be removed to not less than 3 feet below subgrade for street pavement, curb and sidewalk. Within areas where the required subgrade is that for a structure or like facility, or where excavation is to graded ground upon which no construction is called for under the contract, removal of subsurface obstacles shall be to not less than one foot below such subgrade or ground surface.

203.03 EXCAVATION OF UNSOUND SUBGRADE MATERIAL.--The Contractor, where and as shown on the plans, and where and to the extent directed, shall excavate, as common excavation, all existing topsoil, loam, wet clay, and any other materials determined by the Engineer to be unsound and inferior, encountered at any required subgrade. In place of the unsound materials he shall construct satisfactory compacted backfill, including obtaining and hauling the materials therefor if required. This provision shall apply to subgrade for embankment as well as to subgrade for any other construction.

If the Proposal does not contain a Bid Item for common excavation, or excavation, the excavation of unsound materials to a depth of 12 inches below the existing or required subgrade, whichever is lower, shall be done as Incidental Work; in such case excavation to a depth greater than such 12 inches shall be done only where directed by the Engineer, and, together with the disposal of the material so excavated, will be paid for as "Extra Work" as set forth in Section 111.01.

Construction of required backfill shall be done in accordance with the requirements of Section 206, and shall be done as Incidental Work.

203.04 DISPOSAL OF EXCAVATED MATERIALS.--All excavated materials not in accordance with, or in excess of, requirements for the construction of backfill, fill, and embankment, and except as otherwise specified all trees and other vegetation, complete with their entire root structures, and all humus-containing topsoil, shall be removed from the site by the Contractor as his property, as Incidental Work as specified in Section 108.11.

Such material shall also include excavated pavement, concrete and masonry, including foundations, slabs, and cable car conduit and yokes, all rails except those specified to be salvaged, all ties,

track fittings and appurtenances, and all rubbish and other construction debris.

The Contractor shall not remove from the work, nor waste, any site-excavated material that is in accordance with the specified requirements for backfill, fill, and embankment, except that quantity thereof, if any, that may be in excess of the total quantity required to complete all backfilling and embankment.

The Contractor, in accordance with the requirements of Section 210, shall salvage as the property of the City, all stone curb.

#### 203.05 PAYMENT

General.—Common excavation or excavation, satisfactorily done as specified, will be paid for at the price bid per cubic yard measured in place within the limits shown, specified, or directed, and computed from cross-sections between the existing ground surface, or the lower limit of pavement excavation if the Proposal contains a Bid Item therefor, and the final graded ground surface or constructed subgrade, as applicable, but not including the specified exclusions.

If the Proposal does not contain a Bid Item for such work, it shall be done as Incidental Work as set forth under Section 108.

## **Section 204**

### **Preparation of Subgrade**

204.01 GENERAL.—Subgrade is the plane, curved, or warped surface on which a layer of embankment, backfill, subbase, base, pavement or other material is to be placed. There may also be other subgrades, as that for the replacement of unsound subgrade material; the top of a layer of a material placed, considered the subgrade for the material to be placed immediately thereon; and trench subgrade.

Pavement subgrade, where untreated rock subbase is specified to be placed, will be the subgrade for such subbase.

Reference to any subgrade other than that for pavement subbase or base shall be particular and specific.

The Contractor shall do all the necessary or required shaping and grading so that the compacted finished subgrades and graded ground within the limits of the work, will present a smooth, uniform surface and conform to the alignment, grades and contours shown on the plans and cross sections. The surfaces shall contain no local depressions that will hold water, and at intersections with undisturbed ground shall, by means of a uniform transition, conform thereto.

Areas to be paved shall be prepared to a subgrade at the proper depth below the required surface of the finished pavement. Except as otherwise specified in the Special Provisions or shown on

the plans, the elevation and cross section of the subgrade shall be such that the finished roadway pavement surface will be 6 inches below the top of sidewalk curb at the gutter, and will have a crown of 1.0, 0.8, or 0.6 percent of the roadway width between sidewalk curbs, when the street grade is respectively, 0 to 3 percent, greater than 3, to 6 percent, or greater than 6 percent.

Subgrade in cut shall be compacted in accordance with the requirements therefor of Section 205.

Where undisturbed ground, compacted, would produce unsound subgrade, such material shall be removed as specified in Section 203.03. Replacement backfill therefor, and the compaction thereof, shall be in accordance with the requirements of Sections 205 and 206.

Subgrade elevations shall not be raised or adjusted to compensate for anticipated settlement under the weight of the pavement.

Before pavement base or pavement is constructed adjacent thereto, the Contractor, unless otherwise specified or specifically allowed, shall construct the concrete curb required to replace existing concrete curb that is not true to line or grade, or shall satisfactorily reset existing granite curb to line and grade, and payment for such work will be made under the appropriate Bid Item, if the Proposal contains such Bid Item.

The Contractor, immediately prior to placing the pavement or pavement base, shall check the subgrade for irregularities by means of a rigidly constructed, spiked template furnished by him. The spikes shall be placed at intervals not greater than 3 inches, center to center. The length and shape of the template and the protruding length of the spikes shall be such that the points of the spikes, when the template is moved along the headers or previously constructed pavement, as applicable, will accurately delineate the crown curve of the portion of subgrade being checked.

No pavement or base material of any kind shall be placed upon any section of subgrade not approved by the Engineer.

Unless otherwise specified in the Special Provisions, not less than 200 linear feet of subgrade shall be prepared in advance of paving operations. After a section of subgrade has been approved for pavement or pavement base construction, the Contractor, by adequate barricading, shall keep the section free of equipment and all traffic, and shall repair at his sole expense damage to any prepared subgrade from any cause whatsoever.

Where necessary, the subgrade shall be properly wetted down with water immediately in advance of laying the pavement.

**204.02 PAYMENT.**—Preparation of subgrade shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 205

### Compaction of Subgrade and Embankment

**205.01 GENERAL.**—The Contractor shall do the work necessary to obtain the required compaction of subgrade and embankment materials.

The methods of testing compaction, including determination of optimum moisture content and maximum density, shall be in accordance with ASTM "Tentative Methods of Test for Moisture-Density Relations of Soils, Using 10-lb. Rammer and 18-in. Drop," Designation D 1557. As stated therein, the term "relative compaction," used hereinafter regarding compaction of backfill or embankment, means the percentage ratio of the field-compacted dry density to the maximum dry density obtainable by compaction at optimum moisture content.

Compaction tests, required by the Engineer as the work progresses, will be conducted and evaluated by the City at no cost to the Contractor.

#### **205.02 CRITERIA**

**Cleared or Excavated Areas.**—The Contractor shall obtain 95% relative compaction of the 6-inch layer of undisturbed material underlying all areas cleared, or from which existing pavement or excavated material has been removed, and which serve as subgrade for backfill, embankment, pavement subbase or base, curb, or pavement, as the case may be. Such compaction shall extend for a lateral distance of not less than 3 feet beyond the neat lines of such areas except where confined to a lesser lateral distance by lagging, or by existing construction to remain.

**Backfill and Embankment.**—The Contractor shall obtain a relative compaction of not less than 95% throughout each layer of all backfill and embankment constructed, except that below the top 3 feet of backfill and embankment the relative compaction shall not be less than 90%.

**Sandy Street Subgrade Material.**—Compaction of material too sandy to be satisfactorily compacted by the usual rolling and tamping shall be effected by watering to the point that the required compaction is obtained by rolling and tamping, or by the use of vibrating rollers or compactors.

**Replaced Excessive Excavation and Unsound Material.**—95% relative compaction shall be obtained in backfilling excavations in excess of those shown on the plans, including those where unsound subgrade materials have been removed, and backfilling overbreaks.

**Filter Material.**—When fine aggregate filter material in accordance with the requirements of Section 900.04 is placed as a layer in backfill, fill or embankment, such material, and the first 12-inch layer of backfill or embankment directly above it, shall be compacted by use of a vibratory compactor.

Loam and Topsoil.—The foregoing compaction requirements do not apply to the placement of loam and topsoil for landscaping.

205.03 EQUIPMENT.—Unless otherwise specified, all compacting equipment shall be power equipment, and shall be capable of obtaining the specified compaction.

If, however, compaction is not sufficiently uniform, or tests show it to be inadequate, the Engineer may require placement in thinner layers or the use of other or additional equipment. Selection of such equipment shall be by the Contractor, and it shall be solely his responsibility to obtain the specified compactions throughout the required volume.

The use of heavy compacting equipment in areas immediately behind retaining walls will not be permitted, and in general only hand-portable power tampers or vibratory compactors will be approved for such compaction.

If small or hand-portable equipment is used, as for compacting narrow berm, confined areas, or behind retaining walls, the thickness of layers and other conditions shall be adjusted as required to obtain the specified compaction.

205.04 PAYMENT.—Compaction shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **Section 206**

### **Embankment**

206.01 GENERAL.—The Contractor shall prepare the subgrade for, and construct, compacted embankment and fill from earth, concrete pavement, other site excavated concrete materials, borrow material from designated on-site areas, and from imported fill material if required. The work shall include all common excavation, the furnishing of imported fill materials except as the provisions of a Bid Item for such furnishing otherwise state; all loading, hauling, stockpiling, depositing, watering, aerating, vibrating, tamping and rolling of the embankment and fill material. The work shall further consist of constructing embankment to bring all surfaces, including those of areas where pavements or unsound subgrade materials have been excavated, to the lines, grades and cross sections required for final graded ground surfaces and subgrades, all where and as shown on the plans and cross sections, including all Incidental Work.

Required topsoil or loam placed on areas of embankment will be paid for as embankment if the Proposal does not contain a Bid Item for loam.

All required benching, scarifying, watering or drying of materials to the required moisture content, shaping and finishing constructed

subgrade as specified in Section 204, and constructing and maintaining the required slopes and ditches, shall be done as Incidental Work.

Backfilling below pavement subgrade of voids left by the removal of subsurface obstacles and removed structural elements shall be done as Incidental Work will not be paid for as embankment.

Materials excavated beyond or below the specified limits shall be satisfactorily replaced by the Contractor at no cost to the City.

The construction of embankment and fill not within the limits shown on the plans or cross sections, or specified to be paid for under a Bid Item, shall be done as Incidental Work.

If the Proposal contains a Bid Item for earthwork, it will contain a Bid Item for either excavation or embankment, whichever is estimated to exceed in quantity, and the other class of earthwork shall be done as Incidental Work.

206.02 MATERIALS.—Embankment, fill and backfill other than that for placement or replacement of topsoil or planting mix, shall consist of approved site-excavated or other material, free of debris, wood, other organic or deleterious matter, and from all other materials that will prevent or adversely affect thorough and permanent compaction.

The composition of embankment, fill and backfill materials shall be at least equal in quality to that of the native material existing at the site. Further, materials, including those excavated at the site, yielding a maximum dry density of less than 112 pounds per cubic foot, when tested in the laboratory in accordance with the compaction text described in Section 205.01, shall not be used as embankment, fill or backfill.

Lumps, ballast, rocks and broken concrete measuring 3 inches or less in greatest dimension may be incorporated into backfill and embankment, and if satisfactorily distributed in earth or other fine materials, pieces not greater than 6 inches in greatest dimension may be so incorporated, provided that such latter pieces be not placed within 3 feet of finished grade or subgrade. Rocks, concrete, or hard lumps of earth larger than allowed shall be broken up before compacting.

Rocks, broken concrete or other solid materials, larger than 4 inches in greatest dimension, shall not be placed in embankment areas where piles are to be placed or driven.

206.03 PROCEDURES.--Existing material to remain will be subject to approval and shall be compacted as specified in Section 205.02.

Except in contained volumes, the compacted material upon which embankment is to be constructed shall be scarified to a depth of 6 inches, and in no case shall backfill, fill, or embankment be constructed upon topsoil or other unsound material.

Excavated untreated rock base shall be used prior to the use of any other material for constructing compacted fill and embankment.

Embankment and fill material shall be spread with a bulldozer

or other equipment upon which the blade precedes the wheels or tracks. If such material is deposited against an existing slope, the depositing shall be in accordance with the requirements of Section 206.05.

The materials for, and placement of, backfill, fill and embankment above and against structures, sewers and the like shall be as specified in the applicable of Sections 304 and 409. The Contractor's attention is directed to the possibility of excessive lateral pressure on, and resultant damage to, retaining walls; he shall, therefore, exercise care in properly placing backfill, fill and embankment behind such walls.

At the time of compaction, materials to be incorporated in backfill, fill, and embankment, shall have the proper uniform moisture content required to obtain the specified relative compaction. The Contractor shall water, or do whatever spreading, mixing and stockpiling is necessary to dry such materials, as the case may be, in order to obtain such proper moisture content.

Where specified or shown on the plans the Contractor shall construct subdrainage facilities within or below volumes of backfill, fill or embankment. He shall furnish and place, in accordance with the requirements of Section 407.04, the required perforated drain pipe with the perforations down, crushed rock or other suitable filter beds, layers of approved impervious material, and rip rap drain troughs.

Material deposited within two feet of final graded ground surface, and of side slopes, the latter measured at right angles to the face of the slope, shall contain clay or other acceptable binder material in a proportion adequate to minimize erosion by wind and rain.

If there are insufficient excavated earth materials for completion of all required backfilling and embankment, the balance of fill material needed to bring the grades to the elevations shown on the plans shall be obtained, at no charge to the Contractor, from a specified on-site "borrow area". If there is no such borrow area, the Contractor shall, as approved by the Engineer, furnish at the site, where and in the quantities required to correct the deficiency, "Imported Fill Material" in accordance with the requirements therefor of Section 207.

In streets requiring embankment, the berm of the compacted embankment shall extend 3 feet beyond the property lines prior to the construction of any curb, sidewalk or pavement.

Slopes shall be maintained to the grade and cross sections shown on the plans until the acceptance of the contract.

**206.04 EMBANKMENT AND FILL LAYERS.** — All embankment and fill, other than sand, shall be placed in horizontal layers not more than 8 inches thick before compaction, and each layer shall be satisfactorily compacted as and to the degree specified in Section 205.02, by means of suitable mechanical equipment. Flooding or jetting, in this case, will not be allowed.

Section 205.02 specifies methods of compaction where the material is sand or too sandy to be satisfactorily compacted by the usual tamp-

ing and rolling. In the case of compaction of such material by vibratory rollers the maximum thickness of layer may be increased to 3 feet.

In all cases, each layer material shall be satisfactorily compacted before placing the next layer thereon.

206.05 PLACING MATERIAL AGAINST SLOPES. --Slopes and slide areas upon which embankment or fill is to be placed shall have all loose material removed therefrom, and shall be benched in level terraces separated by vertical or nearly vertical slopes. Such stepped benches shall each be cut 4 feet horizontally into the slope, and may be cut progressively with the construction of embankment. Final cutting of each bench shall be with hand tools to undisturbed, compact, and stable materials. The material so removed may be incorporated in the embankment, provided such material is in accordance with the requirements of Section 206.02.

206.06 PAYMENT. --Embankment will be paid for at the price bid per cubic yard of compacted embankment satisfactorily constructed, in place, within the limits shown or specified, or where directed, computed from cross sections between the existing cleared or excavated ground surface and the final graded ground surface, or prepared subgrade for the subbase, base, curb, sidewalk, or other construction for which the embankment is required, but not including backfilling specified to be done as Incidental Work.

If the Proposal does not contain a Bid Item for embankment, it shall be done as Incidental Work as set forth under Section 108.

## Section 207

### Imported Fill Material

207.01 GENERAL. --The Contractor shall furnish imported fill material at the site to supplement site-excavated materials required for embankment or fill. The borrow site for imported fill material may be designated by the City.

The work, as applicable, shall include:

- 1) Loading and disposing of by the Contractor as his property, a quantity of site-excavated material unsuitable for use as embankment or fill, equal in volume to the quantity of imported fill material furnished; and
- 2) Excavating and disposing of unsuitable material as necessary, in order to excavate from the borrow area, the material required for embankment or fill;
- 3) All other necessary or required Incidental Work.

Imported fill material is defined as material to be used for embankment or fill, obtained by the Contractor elsewhere than from the site

of the work, and shall be in accordance with the requirements of Section 206.

Before importing any fill material, the Contractor shall incorporate into embankment and fill all site-excavated materials that meet the requirements for embankment.

Any satisfactory material required for embankment and removed from the site by the Contractor, or wasted as a result of his operations, shall be satisfactorily replaced at the site by him at his sole expense.

Imported fill material shall not be delivered to the work until the source has been approved and the material tested and approved as hereinafter specified.

Removal from a borrow area shall be in a manner to obtain thereon the grades shown on the plans.

207.02 TESTING. --The Contractor shall notify the Engineer, in writing, 30 days in advance of hauling imported fill material to the site of the work, of the location of the area and the exact portion thereof from which he will obtain imported fill material.

The Contractor, as Incidental Work, shall excavate test pits in the aforementioned area at least 4 feet square and extending 4 feet below the unacceptable overburden, to expose representative samples of the material.

The City, at no cost to the Contractor, will conduct and evaluate tests of samples from the test pits in its laboratory to determine the acceptability of such material.

Material which, when tested in the laboratory, fails to yield a maximum dry density equal to or greater than 112 pounds per cubic foot, or that is otherwise not as specified, will be rejected.

207.03 PAYMENT. --Imported fill material furnished as specified, will be paid for at the price bid per cubic yard.

If the Proposal does not contain a Bid Item for imported fill material, the furnishing only, of the ordered quantity of such material will be paid for as Extra Work in accordance with the provisions of Section 111, unless the furnishing of required imported fill material is specified to be done as Incidental Work.

In any case, all work to incorporate and compact imported fill material to the lines and grades of required and originally contemplated embankment or fill, shall be done as Incidental Work.

The quantity to be paid for under a Bid Item for imported fill material will be that quantity thereof furnished, where directed, or necessary to make up the deficiency of proper site-excavated material, and measurement of such quantity will be by that one of the following methods specified in the Special Provisions:

- 1) For imported fill from a designated borrow area, by measurement of the original volume, in place, of satisfactory material excavated from the area and placed where required, computed by the average end area, or borrow pit, method.
- 2) For imported fill material not from a designated borrow area,

- by truck measurement, in accordance with Section 110.03.
- 3) For imported fill material from any source, the aggregate volume, in place, of material satisfactorily furnished, computed from the cross sections between the ground line after completion of clearing or pavement excavation, and the final graded ground line or prepared subgrade, as the case may be.

## Section 208

### Concrete Curb

**208.01 GENERAL.** --The Contractor shall construct concrete curb, complete in place, including depressed curb, doweled curb, that monolithic with concrete parking strip, and that to replace existing concrete curb that is defective, out of line, or above or below official grade; all where, as, and to the lines and grades shown on the plans, and where directed, and including preparing the subgrade, constructing and removing forms, providing required keyways, providing the longitudinal and grouted vertical reinforcing in doweled curb, the required verifying and marking of side sewer and Y-branch locations, providing construction joints, protecting, curing, replacing constructed curb damaged, painting, and all other Incidental Work.

Curb shall be depressed at automobile runways and driveways as shown on the plans. The fall across the curb at the driveways shall not be less than  $\frac{3}{4}$  of an inch. The length of the driveway depression shall be 9 feet exclusive of side slopes, except where property owners request otherwise, but shall not exceed 30 feet in length.

Existing sidewalk flags immediately adjacent to curb to be replaced, except over sidewalk basements, shall be removed to neat flag lines to facilitate construction of curb to the required lines and grades, and to insure that sidewalk will conform to such curb. After the curb has been constructed and prior to the replacement of the sidewalk, the Engineer, to achieve more appropriate conform, may order additional flags of sidewalk removed. If the Proposal contains a Bid Item for pavement excavation and for sidewalk, removal and replacement of the sidewalk will be included for payment under such Bid Items.

Under no circumstances shall concrete curb and concrete sidewalk be constructed monolithically.

**208.02 MONOLITHIC WITH PARKING STRIP.** --Concrete parking strip constructed monolithically with the curb will not be included for payment under a Bid Item for curb but will be paid for as concrete pavement. The line of demarcation for the purpose of payment shall be the intersection of the curb face with the concrete pavement at the gutter line. No additional payment will be made for monolithic construction.

208.03 SUBGRADE. --Subgrade for curb shall be prepared in accordance with the applicable requirements of Section 204, and at the level of the subgrade of the adjacent pavement or gutter. When untreated rock subbase is to be provided for the adjacent pavement, the subgrade for curb constructed prior to the laying of such subbase shall be level with the bottom of such subbase; if the subbase is constructed prior to the construction of curb then such compacted subbase shall extend to a line 18 inches behind the curb line and the surface thereof shall be the required subgrade for the curb.

208.04 FORMS. --The forms shall be smooth on the edges and on the sides against which concrete is to be placed. They shall be of sufficiently heavy material to be rigid, and shall be set securely so that the curb, when completed, shall conform accurately to the lines and grades given. No concrete shall be placed before the forms are in position for at least 50 feet ahead, or for the entire length of curb to be placed. They shall be thoroughly cleaned before each setting. All wooden forms shall be wetted before concrete is deposited against them. Except as otherwise shown on the plans, or required, the top of the curb shall be 6 inches above the adjacent gutter.

The forms shall extend to the full depth of the curb and all joints must be tight and even. On the front, the plank or metal must be of one piece to a depth of 3 inches below the gutter grade. The forms must be so set that the finished curb will be 6 inches wide on top, extend at least to the full depth of the pavement, and have a batter of 1 inch in 4 inches on the front. Conform to adjoining vertical curb shall be made with a 4-foot transition from battered to vertical face. The back face shall be vertical.

If the plans show that concrete curb shall contain keyways it shall be so constructed.

208.05 SIDE SEWER, Y-BRANCH, AND OTHER LOCATIONS TO BE VERIFIED AND MARKED ON CURB. --After setting the forms for concrete curb and before placing concrete, the Contractor, by exposing the top 3 inches of the redwood stake placed at the end of the side sewer in conformity with the provisions of Section 307.05, shall verify the locations of all side sewers constructed, reconstructed, or replaced, as the case may be, by him, but which are not to be placed in immediate service. If for any reason the stake is not found, the Contractor shall excavate and expose the pipe. The Contractor shall not cover the exposed stake or pipe, as the case may be, before the concrete work on the curb has been fully completed, nor before being directed to do so by the Engineer.

The letter "S" shall be stamped in the top of the curb over each side sewer which is not yet in service, as required in Section 307.05.

The letter "Y" shall be stamped in the top of the curb opposite each Y-branch from which a side sewer has not been constructed, as required in Section 316.04.

Curb marking of conduit locations shall be as specified in Section 600.07.

208.06 CONCRETE. --The concrete shall be Class "B" as specified in Section 900.

208.07 PLACING CONCRETE. --The concrete shall be well spaded close to the forms, and properly vibrated and tamped, consolidating it so that there will be no rock pockets in either the front or back surface for the full depth of the curb.

The top of the concrete shall be so tamped that an excess of mortar will be brought to the surface.

208.08 CONSTRUCTION JOINTS. --Construction joints shall be cold joints, or shall be constructed through the curb, at each street property line, and at intervals of 15 feet along the block, and shall be placed in alignment with dummy joints in existing concrete pavement or pavement base. In curb returns, the construction joints shall be so spaced that the perimeter shall, unless otherwise specified, be divided into equal lengths of not more than 16 feet, nor less than 5 feet. The joints along the straight curb shall be perpendicular to the top and face of the curb, and those along circular curbs shall be on radial lines. The edges at the joints shall be rounded to 1/8 inch radius with the proper edging tool.

208.09 FINISHING. --The front forms shall not be removed in less than two (2) hours nor more than six (6) hours after placing concrete therein; the back forms shall not be removed in less than twenty-four (24) hours after such placement. Immediately after removing the front forms, the face and top of the curb shall be floated until the surface is true, even, and of a uniform color.

The front and back edges of the top of the curb shall be rounded to a radius of approximately 3/4 inch. These edges shall be straight and to a true grade, and no lip or shoulder shall be left between the rounded edge and the forms.

Curb shall then be troweled to smooth dense surfaces, the rounded edges thereof restored, and finally the surfaces shall be given a brush finish to achieve a non-slip slightly grainy texture.

The top and face of the finished curb shall be true and straight, and the top surface of curbs shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge 10 feet long is laid on the top or face of the curb, the surface shall not vary more than 0.01 foot from the edge of the straightedge, except at grade changes or curves.

208.10 PROTECTION AND CURING. --The concrete shall be cured as specified in Section 900.16.

As soon as the back forms have been removed, the back of the curb shall be backfilled and an 18-inch wide berm constructed to the full height of the curb. Where curb has been constructed on fill, or the sidewalk area is below subgrade, the berm shall be at least 3 feet wide. Such protection shall be done as Incidental Work, and shall remain in place until the sidewalk is constructed.

208.11 DOWELED CURB. --Doweled concrete curb shall be constructed on the existing pavement where and as shown on the plans or specified. It shall be secured by No. 4 reinforcing bars grouted vertically with Class "B" mortar into holes drilled into the pavement at a spacing not greater than 4 feet on centers measured along the centerline of the curb. Such bars shall be 10 inches long and the holes therefor 6 inches deep. The Contractor shall reinforce the curb longitudinally with a continuous No. 4 bar seated one inch below the top of the vertical reinforcing and tied to it with No. 14 wire.

All requirements of this Section 208, to the extent that they reasonably can apply to the construction of doweled curb, apply in every respect.

Payment for doweled curb shall include full compensation for the required longitudinal and grouted vertical reinforcing bars.

208.12 REPAIR AND REPLACEMENT. --Where any curb requires repair before acceptance, the repair shall be made by removing and replacing the entire section between joints and not by refinishing the damaged portion, or resetting a displaced section. Where the plans provide for the removal of existing curb and construction of curb, and the limit of the work specified does not fall on a curb joint, the curb constructed shall join the old curb at the first curb joint beyond the said specified limit.

208.13 PAINTING. --After all other work under the contract has been completed, the face and top of 8-inch concrete curb, including 8-inch doweled curb, shall be completely and uniformly painted with one (1) coat of white traffic lacquer, or approved equal, applied in accordance with the manufacturer's recommendations.

208.14 PAYMENT. --Concrete curb and doweled curb, satisfactorily constructed as specified, each will be paid for at the respective price bid per linear foot, measured horizontally along the curb line, excluding from such quantity the length of curb line occupied by curb inlet construction.

## Section 209

### Combined Concrete Curb and Gutter

209.01 GENERAL. —The Contractor shall construct combined concrete curb and gutter where, of the dimensions, and to the lines and grades shown on the plans, or where directed, complete in place, including all Incidental Work and in accordance with all applicable requirements of Section 208, except that, in the gutter area, the joints that are truly construction joints shall be as specified for such joints in Section 216.07 and shall be keyed, and other joints, spaced at 15-foot centers, shall be dummy joints as specified in Section 216.08.

The edge of the gutter shall be rounded with an 1/8-inch radius edging tool.

The back of the curb and longitudinal edge of the gutter shall contain keyways as shown on the plans.

Where the gutter grade is less than one percent, the concrete forming the gutter, for the entire length thereof, shall be carefully hand steel troweled for a distance of one foot out from the curb.

209.02 PAYMENT. —Combined concrete curb and gutter, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, measured horizontally along the curb line, excluding from such quantity the length of curb line occupied by curb inlet construction.

## Section 210

### Stone Curb

210.01 GENERAL. —Stone curb is California granite, and each installed piece should be at least 4 feet long, approximately 6 inches thick at top and bottom and 16 inches deep, and should be at line and grade and free from defects or flaws impairing its usefulness as curb.

The Contractor shall remove and reset existing stone curb that is out of alignment or not at proper grade, or shall remove, salvage, deliver, and replace, with City furnished stone curb, that which is damaged or defective, as the case may be, where shown on the plans, specified, or directed by the Engineer, and in conformity with the required lines and grades, and including all required cutting, dressing, marking, and other Incidental Work.

The cost of excavating in connection with work on stone curb shall be included in the prices bid, and neither the volume of such excavating, nor that of the curb, will be included in the quantity to be paid for under any excavation Bid Item.

210.02 REMOVED CURB AND ADJACENT SIDEWALK. --All existing stone curb, and pieces thereof, removed by the Contractor and not to be reset, shall be salvaged and delivered by him to the City's Yard on Jerrold Avenue between Phelps and Quint Streets, and there stacked where directed, all as Incidental Work. Stone curb hauled to the Yard shall not include other excavated materials.

Existing sidewalk flags immediately adjacent to curb to be reset or replaced, except over sidewalk basements, shall be removed to neat flag lines to facilitate the installation of curb to the required lines and grades, and to insure that sidewalk will conform to such curb. After the curb has been installed, and prior to the replacement of the sidewalk, the Engineer, to achieve more appropriate conform, may order additional flags of sidewalk removed. If the Proposal contains a Bid Item for pavement excavation and for sidewalk, removal and replacement thereof will be included for payment under such Bid Items.

210.03 CITY TO FURNISH STONE CURB. --Stone curb, in lieu of that at the site, required for the work will be furnished by the City at no cost to the Contractor. However, such curb shall be loaded and hauled by him to the site of the work from the hereinbefore specified Yard.

Stone curb for curb returns will be furnished precut to the prescribed curvature, with joints on true radial lines.

The Contractor shall give the Bureau of Street Repair, 2323 Army Street, notice in writing, endorsed by the Engineer, ten (10) days in advance of each desired withdrawal of stone curb from the City's Yard. Such notice shall be given for each requisition for curb and shall specify the linear feet of straight section and linear feet of each curb radius required.

210.04 DESIRED TOLERANCES. --The top of the curb and its face for a depth of 6 inches shall have a first class peen-hammered finish. These surfaces shall be true and properly squared. A tolerance of 1/4 inch may exist in the width of the top of curb. The back of the curb, for a depth of 2 inches, shall be pointed to a fair surface, free from inequalities exceeding 1/2 inch. The ends of each length of curb shall be square to form uniform vertical joints for a depth of 8 inches. Below the dressed portion, the curb ends should not be more than 1/4 inch under square. Corners bordering dressed surfaces shall be sharply defined.

Where gutters are deeper than 6 inches, the face of the stone curb shall be peen-hammered to the full depth of the gutter. The lower part of each stone shall be roughly squared, and should have an average thickness of not less than 6 inches at the bottom and at no point shall the thickness be less than 4 inches.

No additional payment will be made for removing, resetting or installing stone curb that is over or under 6 inches in width.

210.05 RESETTING AND INSTALLING. --Stone curb shall be set to line and grade as hereinbefore specified. Before resetting or installing

stone curb, the Contractor shall clean, dress, cut to size and square the ends thereof, as approved by the Engineer.

Where the subgrade is not suitable for supporting the curb, it shall be removed and replaced with sand, gravel, or concrete. When properly in place, the back of the curb shall be backfilled and supported for its full height by an 18-inch wide berm. Where the sidewalk area is below subgrade, the berm shall be at least 3 feet wide.

Adjacent lengths of stone curb shall be installed tight butted, and the width of joint throughout the dressed portion of the ends should not exceed 1/4 inch.

At driveways, the Contractor shall reset or install stone curb one inch above the gutter, and at each end of the drop curb shall provide bevels 18 inches long, measured horizontally.

The Contractor shall reset curb over subsidewalk basements in a manner to not cause damage or leaks therein, and shall be responsible for repairing any such damage or leaks due to his operations.

210.06 CURB TO BE MARKED. --The Contractor shall neatly cut into the curb all marks for which he is responsible and shall include reproducing the marks in existing curb replaced. Side sewer and other locations shall be verified and marked on the curb in accordance with the requirements of Sections 307.05, 316.04 and 600.07.

210.07 PAYMENT. --Replacing and resetting existing stone curb each will be paid for at the respective price bid per linear foot, measured horizontally along the curb line.

## Section 211

### Concrete Sidewalk

211.01 GENERAL. --The Contractor shall construct concrete sidewalk at least 3-1/2 inches thick, where and as shown on the plans or where directed, including preparing the subgrade, constructing and removing forms, providing the specified joints and doing the required finishing, marking, protecting, curing and other Incidental Work.

The concrete shall be Class "C" as specified in Section 900, and shall be darkened by the addition thereto at the mixer of either:

- 1) lampblack in dry form, in accordance with the requirements of ASTM "Standard Specifications for Lampblack," Designation D 209, in the proportion of from 1/2 to 3/4 pound per cubic yard of concrete; or
- 2) an approved liquid or semi-paste black colorant intended for use integrally in concrete mixes. The proportion required, generally from 10 to 40 ounces liquid measure per cubic yard of concrete, may be affected by the colorant used. Curing in this case shall be by the impervious membrane method.

The proportion of lampblack or other approved colorant, to a great extent dependent on the color of the cement used in the mix, shall be that required to properly darken the concrete to reduce glare, and shall be subject to the approval of the Engineer. The proportion in batches for adjacent sidewalk shall be identical.

Sidewalk shall in no case be constructed monolithic with curb.

The limits of sidewalk removal and construction will be specified or shown on the plans. Beyond such limits, the removal and construction of sidewalk will be included for payment under Bid Items for such work only where specifically ordered by the Engineer.

211.02 SUBGRADE. --The subgrade shall be prepared by grading to at least 3-1/2 inches below the required elevation of the sidewalk surface. The subgrade shall be thoroughly tamped or, if sand, vibrated or compacted with water to a firm, stable foundation for the sidewalk. All unsound material shall be removed from the subgrade, compacted fill constructed, and the surface prepared as hereinbefore specified.

211.03 FORMS. --Forms shall be not less than 3-1/2 inches in depth, clean, smooth on the upper edge and on the side against which concrete is to be placed, shall be of sufficiently heavy material and braced so as to be rigid, and shall be set so that the sidewalk, when completed, will conform accurately to the required alignment and grades. The forms shall remain in place for not less than twelve (12) hours after the finishing has been completed.

211.04 SLOPE. --Unless otherwise specified, the finished surface of the walk shall rise 1/5 inch per foot from curb grade to property line.

211.05 CONSTRUCTION. --Immediately before placing concrete, the forms and subgrade shall be thoroughly wetted. Immediately after the concrete has been placed it shall be thoroughly tamped so that the mortar will flush to the top, and the surface shall then be struck off with a straight edge.

All standards, street and traffic signs, parking meters, sewer trap vent frames and covers, including adjusting the length of riser therefor, oil tank filler pipe covers, and the like, that require resetting to the new sidewalk level, shall be reset by the Contractor to the proper elevations as Incidental Work.

211.06 FINISHING. --When the concrete has sufficiently set, it shall be floated to a true and uniform surface and finished with a steel trowel, after which the smooth surface shall be brushed transversely across the sidewalk with a bristle brush to produce a uniform, non-skid, texture. On grades over 10 percent a rougher surface will be required. This may be accomplished by lifting a wood float straight up from the surface of the concrete.

The surface shall be marked, with an 1/8-inch radius edging or scoring tool as applicable, into rectangles not less than 2.5 nor more

than 4 feet on a side. These markings shall be made at every construction and weakened plane joint and the intervening space marked off equally. The markings in the completed sidewalk shall be well defined.

211.07 JOINTS. --Transverse joints in sidewalk shall extend across the entire width of the walk at right angles to the curb line. They shall be provided across sidewalk at the points of beginning and end of all curb returns, at lot lines, and additionally approximately 30 feet apart. Except for the lot line requirement, joints shall be located opposite a construction joint in concrete curb. Each joint shall consist of either a weakened plane joint properly formed by a 2-inch x 2-inch x 1/4-inch steel tee, or a construction or "cold" joint. No joint filler shall be installed in either case.

Where sidewalk abuts building foundation walls, copings, or any rigid structure, including slab, an expansion joint shall be provided between such structure and the sidewalk. Expansion joints shall be constructed by placing approved 1/8-inch thick, pre-molded expansion joint filler strip, or 2 thicknesses 30-pound weight asphalt saturated felt, 3-1/2 inches wide, vertical, and suitably supported against the structure at all points of its juncture with sidewalk. Where it is necessary to splice the filler strip or paper, the pieces shall be tightly butted across their entire width.

211.08 STREET NAMES. --On all sidewalks constructed at street intersections the names of the intersecting streets shall be impressed, opposite the crosswalk or crosswalks, as approved by the Engineer, in letters and numerals 4 inches high and 1/2-inch deep.

211.09 PROTECTION AND CURING. --The protection and curing of concrete sidewalk shall be as specified in Section 900.16.

#### 211.10 3-1/2-INCH CONCRETE PAVEMENT

General. --3-1/2-inch concrete pavement used to pave traffic islands shall be identical to 3-1/2-inch concrete sidewalk, except that the concrete shall not be darkened by lampblack or other colorant. Bidders shall include in the price bid for the pavement all charges for the following Incidental Work.

Sand Fill. --Where islands are to be constructed over existing pavement, the Contractor shall furnish and place sand fill to subgrade for the 3-1/2-inch concrete pavement.

Painting. --After all other work in the area has been completed, the surface of the return areas at the ends of 3-1/2-inch concrete center islands 4 feet or less in width shall be completely and uniformly painted with one (1) coat of white traffic lacquer, or approved equal, applied in accordance with the manufacturer's recommendations.

211.11 PAYMENT. --Concrete sidewalk and 3-1/2-inch concrete pavement, satisfactorily constructed as specified, each will be paid for at the respective price bid per square foot, measured horizontally.

The area of curb adjoining sidewalk, and areas occupied by curb inlets will not be included in measurements of area of sidewalk.

The areas of poles, standards, other fixtures, and of boxed-out locations for manhole and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of concrete sidewalk or 3-1/2-inch concrete pavement for which payment will be made.

## Section 212

### Redwood Headers

212.01 GENERAL. --The Contractor shall construct "Heart Structural" grade redwood headers 2 inches thick and of a width equal to the thickness of the pavement or walk which they are to be bound, complete in place, including supporting stakes, scabs, wood preservative treatment, nailing, and Incidental Work. The headers shall be placed on edge, and securely nailed inside of supporting stakes driven into the subgrade. They shall be set so as to conform to the finished surface of the pavement. The supporting stakes shall be "Heart Structural" grade redwood set with their sawed tops conforming with the surface of the finished pavement or walk, of such size and number as may be necessary to rigidly support the headers in place during the construction operations. The headers shall have squared top edges and squared butt joints against the stakes, and shall be held in place with at least 2 nails of the necessary length in each stake, except at butt joints where not less than 4 shall be used. In sandy or loose soil, or wherever necessary to hold headers to proper line and grade, the joints in the headers shall be reinforced with a 1-inch x 6-inch x 18-inch redwood scab, securely nailed.

Headers shall be placed where indicated on the plans, and along the unprotected edges of all pavements and sidewalks, except concrete sidewalks at property lines, even though not called for on the plans.

After being cut to length, the headers, stakes and scabs shall receive on-the-job wood preservative treatment as specified in Section 427.06, with 5-percent pentachlorophenol preservative. Preservatives containing arsenic or creosote will not be permitted.

212.02 PAYMENT. --Redwood headers, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, measured horizontally along the line thereof.

Section 213  
Aggregate Base

213.01 GENERAL. --The Contractor shall construct mineral aggregate base of the specified thickness after compaction, spread and compacted to the lines, grades and dimensions shown on the plans and cross sections, and where directed, including preparing the subgrade and doing the required watering, shaping, smoothing and other Incidental Work.

213.02 MATERIALS. --The aggregate shall be free from vegetable matter and other deleterious substances. Aggregate for aggregate base shall consist of material of which at least 60 percent by weight shall be crushed particles as determined by Test Method No. Calif. 205.

The percentage composition by weight of aggregate base shall conform to one of the following gradings when determined by Test Method No. Calif. 202.

Unless otherwise specified in the Special Provisions, the particle size distribution shall be in accordance with the grading specified for the 1-1/2-inch maximum size aggregate.

Sieve Sizes	Percentage Passing	
	1-1/2"	3/4"
	Maximum	Maximum
2" .....	100	...
1-1/2" .....	90-100	...
1" .....	...	100
3/4" .....	50-85	90-100
No. 4 .....	25-45	35- 55
No. 30 .....	10-25	10- 30
No. 200 .....	2- 9	2- 9

The aggregate base shall also conform to the following quality requirements:

Tests	Test Method	
	No. Calif.	Requirements
Resistance (R-value)* .....	301	78 Min.
Sand Equivalent .....	217	30 Min.
Durability Index .....	229	35 Min.

\*The R-value requirement will be waived provided the aggregate base conforms to the specified grading and durability and has a sand equivalent value of 35 or more.

Material yielding a maximum dry density of less than 112 pounds per cubic foot when tested in the laboratory in accordance with ASTM "Tentative Methods of Test for Moisture-Density Relations of Soils, Using 10-lb. Rammer and 18-in. Drop," Designation D 1557, shall not be used.

Any rock, including red rock, meeting all the requirements of this Section will be acceptable. Such rock shall be plant processed at an approved processing plant.

213.03 SPREADING. -- Aggregate base material shall be delivered to the roadbed as uniform mixtures and each layer shall be spread in one operation.

At the time aggregate base is spread it shall have a moisture content sufficient to obtain the required compaction. Such moisture shall be uniformly distributed throughout the material.

The material shall be spread upon the subgrade prepared in accordance with the requirements of Section 204, by means of vehicles equipped with approved spreading devices at a uniform quantity per linear foot, which quantity will provide the required compacted thickness within the tolerances specified in Section 213.04.

Depositing and spreading shall commence at that part of the work farthest from the supply of base material and shall progress continuously without breaks, unless otherwise directed by the Engineer.

Where the required thickness is 6 inches or less, the base material may be spread and compacted in one layer. Where the required thickness is more than 6 inches, the base material shall be spread and compacted in two (2) or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. Each layer shall be spread and compacted in a similar manner.

Base material placed in areas inaccessible to the spreading equipment, may be spread in one or more layers by any means that will make possible the specified compaction and surface.

When the subgrade for aggregate base consists of cohesionless sand, and written permission is granted by the Engineer, the base material may be dumped in piles upon the subgrade and spread ahead from the dumped material.

The base material, after spreading, shall be shaped by means of a blade grader to such thickness that after watering and compacting, the completed base will conform to the required grade and cross section within the tolerances specified in Section 213.04.

Segregation of aggregate shall be avoided and the base shall be free from pockets of coarse or fine material.

213.04 COMPACTING. -- Immediately following spreading, shaping and smoothing, the full width of the base material shall be watered as ordered by the Engineer, and compacted by rolling with a minimum of two (2) pieces of self-propelled reversible equipment. Compaction shall be as follows:

- 1) For initial rolling use a 3-wheel steel-tired roller, weighing not less than 12 tons distributed so that the rear wheels will apply to the surface being rolled not less than 325 pounds per linear inch of rear tire width. Rolling shall commence by covering completely the outer edge of the material. Subsequent passes shall lap at least 25 percent on previously rolled material.

- 2) For subsequent rollings use a pneumatic-tired roller of the oscillating type, having a width of not less than 4 feet and equipped with tires of equal size and diameter. Wobble wheel rollers will not be permitted. The tires shall be so spaced that the entire gap between adjacent tires will be covered by the tread of the following tire. The tires shall be inflated to 90 pounds per square inch minimum.
- 3) To compact all areas inaccessible to the rollers, use compressed air, or gas, powered tampers.

The foregoing equipment requirements serve as a standard of adequacy.

Subject to the condition that the Contractor shall notify the Engineer at least ten (10) days in advance, and shall secure approval for the use of each piece of compacting equipment other than that specified, selection thereof and obtainance of the specified compaction throughout the volume of base, and the specified surface, shall be solely the responsibility of the Contractor.

If compaction is not uniform or tests show it to be inadequate, or if the surface is unsatisfactory, the Engineer may require the use of other or additional equipment.

Should low or high spots develop during rolling operations, such spots shall be smoothed out by blading with a self-propelled and pneumatic-tired motor grader having a wheelbase not less than 15 feet long and a blade not less than 10 feet long.

Aggregate base shall be watered after compaction. Water shall be applied at the rate and in the quantities ordered by the Engineer.

The relative compaction of aggregate base, determined by tests of the in place, field compacted base shall be not less than 95 percent of the maximum compaction at optimum moisture content determined by ASTM Methods of Test, Designation D 1557. The tests will be conducted and evaluated in the laboratory by the City at no cost to the Contractor.

The surface of the finished aggregate base at any point shall not vary more than 0.05 foot above or below proper grade, and such surface shall contain no ridges, valleys or sharp breaks.

Finished base that does not conform to the foregoing requirement shall be reshaped or reworked, watered, and thoroughly recompacted to conform thereto.

The Contractor shall not allow any completed untreated rock base to be subjected to public or construction traffic except the latter necessary to the completion of the overlying surface course.

**213.05 PAYMENT.**—Aggregate base, satisfactorily constructed as specified, will be paid for at the price bid per ton.

All satisfactorily completed temporary and permanent aggregate base constructed in conjunction with the setting and resetting, as the case may be, of castings and, in accordance with the requirements of Section 202, specified to be done by the Contractor, will be paid for under the Bid Item for aggregate base.

## Section 214

### Plant-Mixed Cement Treated Rock Base

214.01 GENERAL.—The Contractor shall construct plant-mixed cement treated rock base, unless otherwise specified 6 inches thick after compaction, where and to the lines and grades shown on the plans or directed, including submitting the required aggregate samples, preparing the subgrade, doing the required watering, spreading, compacting, and trimming, furnishing and applying curing seal, and doing other Incidental Work.

214.02 PORTLAND CEMENT.—Portland cement shall be in accordance with Section 900. The quantity of cement to be added to the aggregate will be between  $2\frac{1}{2}$  percent and  $4\frac{1}{2}$  percent by weight of the dry aggregate. The actual percentage to be used will be determined by the Engineer after receipt of the hereinafter specified aggregate samples.

214.03 MINERAL AGGREGATE.—Mineral aggregate shall be as specified in Section 213.02 for the 3/4-inch maximum grading. Further, the graded aggregate shall be of such quality that, when mixed with Portland cement in an amount not to exceed  $4\frac{1}{2}$  percent by weight of the dry aggregate, the compressive strength of a sample of the compacted mixture shall be not less than 500 pounds per square inch at seven (7) days when tested by Test Method No. Calif. 312-B modified as follows:

- 1) Optimum moisture content of the cement treated rock base shall be determined using the procedures outlined in ASTM "Tentative Methods of Test for Moisture-Density Relations of Soils, Using 10-lb. Rammer and 18-in. Drop," Designation D 1557.
- 2) Compaction of the test specimens shall be as outlined in ASTM Methods of Test, Designation D 1557.
- 3) Capping compound shall be sulphur instead of plaster of Paris.

214.04 SAMPLES AND TESTING.—At least ten (10) working days prior to the start of mixing operations, the Contractor shall submit to the Engineer a 120-pound sample of each aggregate, graded as intended for use. This requirement shall be complied with for each aggregate and grading thereof that has not been approved. The Engineer will test the sample at no cost to the Contractor, and will determine the acceptability of the aggregate and percentage of cement and amount of water to be added thereto.

214.05 MIXING.—Cement treated rock base shall be mixed at a central mixing plant by either batch type mixing using revolving blade or rotary drum mixers or continuous mixing. Weight or volumetric proportioning may be employed. The resulting mix shall be equal to that produced by weight proportioning and batch type mixing.

The water shall be proportioned by weight or volume and there shall be means by which the Engineer may readily verify the amount of water per batch or the rate of flow for continuous mixing. The time of the addition of water or the points at which it is introduced into the mixer, shall be as approved by the Engineer.

Cement shall be added in such a manner that it is uniformly distributed throughout the aggregates during the mixing operation.

The mixers used must be able to produce uniformly mixed batches. The charge in a batch mixer, or the rate of feed to a continuous mixer, shall not exceed that which will permit complete mixing of all the material. The materials shall be mixed for not less than thirty (30) seconds after all the ingredients are in the mixer.

The mixed materials shall be protected by covers against moisture loss while being transported to the site.

**214.06 SPREADING.**—The subgrade, prepared in accordance with the requirements of Section 204, shall be moistened immediately prior to the spreading operation.

The mixing materials shall be deposited and spread with a self-propelled spreader, ready for compaction without further shaping. Equipment not propelled by the unloading vehicle will be considered self-propelled. The spreader shall be provided with a screed that strikes off and distributes the materials to the required width and thickness.

Depositing and spreading shall commence at that part of the work farthest from the supply of base material and shall progress continuously without breaks, unless otherwise directed by the Engineer.

If a spreader box is used, it shall at all times during the simultaneous operation thereof and receipt of materials thereby, push the vehicle that has transported the cement treated base material in a manner such that the latter exerts a downward force on the spreader box sufficient to force spreading and screeding at the proper grade with no "riding up" on the deposited material. Further, in all cases there shall be positive provision preventing the spreader box from contacting the rear wheels of the transporting vehicle during the pushing operation.

The mixed materials shall be deposited and spread in one lift if the thickness is not to be more than 6 inches, and in this case depositing in layers will not be allowed. If the thickness is to be more than 6 inches, the base shall be spread and compacted in two (2) layers of approximately equal thickness, and the surface of the compacted material shall be kept moist until covered with the next layer.

Cement treated base placed in areas inaccessible to the spreading equipment may be spread by any means that will achieve the specified compaction and surface.

**214.07 COMPACTING.**—Immediately following the spreading operation, the mixed materials shall be compacted in the manner and to the degree and accuracy of surface specified in Section 213.04, except that the shifting of material by a motor grader to smooth low and high spots

that develop during rolling will not be allowed, nor will any reshaping or reworking of the cement treated base, although high spots may be trimmed, provided the excess material is removed and immediately disposed of, no loose material is left on the base, and the area is again rolled.

Except for the aforementioned trimming, cement treated base, the finished surface of which is outside the specified tolerances, or which is otherwise unsatisfactory, shall be neatly cut out, immediately removed from the site and replaced with fresh material properly compacted as hereinbefore specified.

Not more than two (2) hours shall elapse between the time water is added to the aggregate and cement, and the time of completion of initial rolling. Not more than three (3) hours shall elapse between the time water is added to the aggregate and cement and the time of completion of final rolling after any required trimming.

The surface of the compacted cement treated rock base shall be kept moist until the curing seal is applied.

The Contractor shall not allow any completed cement treated rock base to be subjected to public or construction traffic, except the latter necessary to the completion of the overlying surface course.

214.08 CONSTRUCTION JOINTS. -- At the end of each day's work, a construction joint shall be made in the thoroughly compacted material, normal to the centerline of the roadway. Additional material shall not be placed until the construction joint has been approved by the Engineer.

Longitudinal joints when necessary shall be constructed by cutting vertically into the existing edge for approximately 3 inches. Material cut away may be disposed of in the adjacent area to be constructed. The face of the cut joints shall be moistened in advance of placing the adjacent base.

214.09 CURING SEAL. -- The complete surface of the cement treated rock base shall be covered with an emulsified asphalt curing seal. Emulsified asphalt shall be as specified in Section 220.05, and in accordance with the specifications for Grade SS-1 of the Asphalt Institute. Application shall be at the rate of 0.15-gallon per square yard.

The emulsion may be diluted with water up to a ratio of one to one, as required, as determined by the Engineer, for the application of a thin uniform coat. The rate of application of the originally specified emulsion, however, shall remain 0.15-gallon per square yard regardless of dilution.

The curing seal shall be applied as soon as possible, but not later than eight (8) hours after completion of final rolling.

214.10 PAYMENT. -- Plant-mixed cement treated rock base of the specified thickness after compaction, satisfactorily constructed as specified, will be paid for at the price bid per square foot, measured horizontally.

Cement treated rock base constructed adjoining curb will be meas-

ured from the face of curb at a depth of 6 inches below the top of curb, irrespective of the actual depth, and when constructed adjoining combined curb and gutter or curb and parking strip, shall be measured from the adjoining edge of gutter or parking strip.

The areas of poles, standards, other fixtures, and boxed-out locations for manhole and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of plant-mixed cement treated rock base for which payment will be made.

## Section 215

### Concrete Base

**215.01 GENERAL.**--The Contractor shall construct concrete base of the thickness specified or shown on the plans, including preparing subgrade, constructing and removing side forms, providing the specified joints, and calcium chloride in the mix if required or used, and doing the required finishing, protecting, curing and other Incidental Work. The concrete therefor shall be properly and uniformly distributed and thoroughly and adequately vibrated, screeded and tamped by a machine or machines, self-propelled and supported on the required side forms, or on adjacent pavement base or pavement in accordance with the hereinafter specified restrictions on such support. Vibrators independent from the self-propelled machine shall not rest on the side forms.

**215.02 SUBGRADE.**--The adjustment of manhole frames and other castings and the preparation of subgrade shall be as specified in Sections 202 and 204, respectively.

**215.03 SIDE FORMS.**--Metal side forms shall be used exclusively and shall weigh, not including stakes, not less than 10 pounds per linear foot. They shall be clean, straight, of uniform section, free from defects, and shall be constructed to form parallel strips not more than 24 feet, nor less than 4 feet, wide. Side forms shall be of the required depth in one piece, have a base width of not less than 8 inches, and be such as to form the keyway hereinafter specified for longitudinal joints. The strips shall be constructed to coincide with vehicular traffic lanes unless otherwise specified or shown.

Where, as specified in Section 215.05, a self-propelled vibrating, screeding and tamping machine is not required, the maximum width of strip shall be reduced to 14 feet.

The forms shall be placed true to line and grade and rigidly stayed. There shall be no lateral or vertical movement of the forms while the concrete is being spread or finished.

Top surfaces of side forms shall be set to the same elevation as that of the finished concrete base. The depth of side forms shall be equal to the specified thickness of the concrete base.

After the side forms have been accurately and securely set to

line and grade, the Contractor shall check the subgrade with a scratch template as specified in Section 204.01. The template shall be supported on the side forms, previously poured concrete strips, or both, as applicable, and shall be carefully drawn the full length of the subgrade to check the grade. High spots shall be cut down to grade and low spots filled and satisfactorily compacted to grade.

At least 200 feet of subgrade and side forms shall be prepared in advance of the placement of concrete. After the subgrade and side forms for any strip have been prepared and accepted, barricades shall be so placed that there will be no equipment or traffic of any kind thereon.

No adjustment shall be made in the subgrade to allow for anticipated settlement under the pavement load, and no direct or additional payment will be made for additional concrete used, or claimed to have been used, on account of such settlement.

215.04 CONCRETE.--Concrete for concrete base shall be Class "C-1" in accordance with the requirements of Section 900.

The Contractor, at his option, to accelerate setting of the concrete, may use the admixture of 2 pounds calcium chloride per sack of cement, in accordance with the provisions of Section 900.08.

215.05 PLACING CONCRETE.--The use of an approved self-propelled, mechanical, concrete vibrating, screeding and tamping machine will be required unless otherwise specified in the Special Provisions, or unless restricted space does not permit the use thereof.

Immediately before placing concrete, the subgrade shall be watered with a spray nozzle to the extent that it will not absorb any moisture from the concrete, but there shall be no standing water on the subgrade. After the subgrade has been wetted in the manner set forth hereinbefore, the concrete shall be placed in accordance with the requirements of Section 900.14, and spread so that the vibrated, screeded and tamped base will be of the required thickness and cross section and at the required grade.

The self-propelled, mechanical, concrete vibrating, screeding and tamping machine used shall have, in addition to the spreading, screeding, and vibratory compaction action, a tamping or kneading action, and shall produce a surface satisfactory to the Engineer.

The machine may ride on adjacent existing or newly constructed pavement base or pavement. Such arrangement, however, must satisfy the Engineer, and the Contractor shall make any required correction to the surface of such base or pavement and provide required protection of the surface and of the edge thereof.

The concrete shall be evenly distributed in front of the machine to prevent unequal loads against the front cut-off screed or screeds.

The machine shall be maintained in perfect operating condition, and the screeds shall hold their crown as set.

Coordination of the forward speed of the machine and the lateral movement of the screeds must be such as to prevent ridging of the concrete surface.

The final action of the vibrating, screeding and tamping machine shall in all cases be accomplished by the use of burlap, leather or other approved type of flexible drag, attached properly to the rear of the machine. The drag shall leave the surface of the concrete ridgeless, even and uniform. Should there be any rock pockets or voids in the surface after the passage of the machine, they shall be immediately repaired by adding concrete, thoroughly working it in, and restoring the surface of the base.

The finished surface of the concrete base shall be smooth and free from texture disfigurations caused by floats or any other type of equipment or tools used to remove surface defects. Such tools may be used, but after their use a final pass must be made with the machine.

The vibrating, screeding and tamping machine shall back up and pass over the surface as many times as are necessary to establish a true and even crown and a ridgeless, even and uniform surface over the entire pavement base area.

If an approved vibrating, screeding and tamping machine is not used, all concrete placed shall be vibrated in accordance with the requirements of Section 900.14, and then tamped with a transverse tamper until the surface is dense and smooth. Should there be any rock pockets or voids in the surface after tamping, they shall be immediately repaired by adding concrete, thoroughly working it in, and retamping to restore the surface of the base.

The tamper shall be at least 6 inches in width and not less than one foot longer than the width of the strip, shall be accurately shaped to conform to the crown of the pavement, and shall be of rigid construction. It shall be equipped with handles at each end, and operated in a direction at right angles to the centerline of the pavement. While one end of the tamper is held stationary, the workman at the other end shall tamp the concrete, advancing slightly with each downward motion of the tamper. When he has advanced his end of the tamper about 12 inches, he shall then hold it stationary while the workman at the other end tamps in a similar fashion.

#### 215.06 CONSTRUCTION JOINTS

General.—At the beginning and end of every strip not in contact with existing pavement base, at the end of each day's construction, or where the placing of concrete is interrupted for a period of one (1) hour or more, a vertical construction joint shall be provided prior to the resumed placing of concrete. The construction joint shall be formed by finishing the base square across the strip against a header, 3 inches thick, of a width equal to the depth of the base, and shaped so that it will form a keyway as shown on the plans. The header shall conform to the correct cross section of the base, shall be placed perpendicular to the subgrade, and its top shall be at all points at the correct elevation at the top of the base.

The concrete shall not be edged.

Prior to the resumption of work, surplus concrete on the subgrade shall be cleared away, and the header shall be removed in

such a manner as to avoid damage to the edge of the concrete.

Longitudinal Joints.--Longitudinal joints between adjacent pours of concrete base, between concrete base and concrete parking strip or gutter, and between concrete base and curb, shall be keyed as shown on the plans.

The keyway shall be formed in the first of adjacent pours.

Where adjacent pours are 8-inch thick concrete base and concrete parking strip or gutter, the vertical position of the keyway and key shall be as shown on the plans.

The concrete shall not be edged.

#### 215.07 DUMMY JOINTS

General.--Transverse dummy joints shall be placed at 15 feet on centers, for the full width of the pavement, in alignment with the joints of adjacent concrete pours, and at right angles to the centerline of the street. Each joint shall be constructed by forming a transverse groove in the pavement base and installing therein a formed strip of joint insert, as shown on the plans.

Joint Filler Strip.--Each joint filler strip shall be an approved one-piece premolded strip at least 1-3/4 inches, and not more than 2 inches, wide, sufficiently long to extend the full width of the pavement less 1/2 inch. Splicing of a joint filler strip will not be permitted, except that where pour widths exceed 12 feet one splice will be permitted. The thickness of the strip shall not exceed 1/4 inch and shall be uniform within a variation of not more than 10 percent.

Joint filler strip shall be in accordance with the requirements of ASTM "Tentative Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction," Designation D 1751.

Construction.--Following the pass of the vibrating and screeding equipment, but before the final dragging or brushing, the joint groove shall be formed by means of an iron cutter with a blade at least 3 inches in depth and 1/4-inch thick. The cutter shall have some means of controlling the depth of insertion and shall not have any horizontal surfaces, except the edge, that contact the concrete. A movable bridge supported on the forms or adjacent concrete shall be provided to assure minimum disturbance to the concrete during joint construction operations. The bridge shall be at least 2 inches clear of the concrete surface when loaded with 300 pounds at its center and supported on the forms or adjacent pavement.

The depth of the groove shall be at least equal to, and not more than 1/4 inch greater than the width of the filler strip to be used.

The steel cutter shall be cleaned after each insertion into the concrete, or the Contractor may use any means approved by the Engineer that will prevent adherence of mortar and aggregate to the cutter and resultant disturbance of the concrete during cutting operations.

The steel cutter shall be mechanically vibrated at a rate of 3,500 vibrations per minute by use of at least one vibrator. At all times during the cutting operations, such vibrators shall be activated.

The joint filler strip shall then be placed in the groove by means of a metal installing device consisting of sheet metal backing plates with

one side the full depth of the strip and the other side extending down 3/4 inch along the opposite side of the strip. The ends of the installing device shall be equipped with an adjustable gauge resting on each side form to control the depth to which the strip is placed. The installing device shall be sufficiently rigid to hold the strip in exact position, and the overall thickness shall not be greater than that necessary to install and release the strip readily.

The Engineer reserves the right to order discontinued, the use of any equipment or material which in his opinion fails to produce a satisfactory joint under the methods employed by the Contractor.

The filler strip shall be placed into the groove completely across the width of the slab, so that the top of the strip is within 1/4 inch of the adjacent concrete surface. Any strip damaged in installing, or during any work on the pavement base, shall be replaced with an undamaged strip.

The concrete shall not be edged and shall be continuous over the insert.

After pavement side forms have been removed, any concrete which has flowed around the ends of the strip shall be removed.

Expansion joints shall not be constructed in concrete base.

215.08 PROTECTION AND CURING.—Concrete base shall be protected and cured in accordance with the requirements of Section 900.16.

No equipment, or public or other traffic shall be allowed on concrete pavement base, nor shall asphalt concrete wearing surface be placed thereon until ten (10) days after the pavement base has been placed, except that when calcium chloride is used in accordance with the requirements of Section 900.08 as an admixture to accelerate the setting of concrete base, public traffic may be allowed thereon only after at least twenty-four (24) hours have elapsed since the completion of all placement of such concrete.

The placement of asphalt concrete wearing surface on such pavement base by use of a self-propelled spreading and finishing machine, however, will not be allowed until forty-eight (48) hours have elapsed since the completion of the placement of the concrete.

In no case shall concrete base remain without wearing surface for more than fourteen (14) days.

215.09 PAYMENT. --Concrete base of the specified thickness, satisfactorily constructed, complete in place as specified, will be paid for at the price bid per square foot, measured horizontally.

Concrete pavement base constructed adjoining curb will be measured from the face of curb at a depth of 6 inches below the top of curb, irrespective of the actual depth.

The areas of boxed-out locations for manhole and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of concrete pavement base for which payment will be made.

## Section 216

### Concrete Pavement

216.01 GENERAL.--The Contractor shall construct concrete pavement, including concrete parking strip monolithic with adjacent concrete curb, of the thickness specified or shown on the plans, including preparing subgrade, constructing and removing side forms, providing the specified joints, and calcium chloride in the mix if required or used and doing the required finishing, protecting, curing and other Incidental Work. The concrete therefor shall be properly uniformly distributed, and thoroughly and adequately vibrated, screeded and tamped by a machine or machines, self-propelled and supported on the required side forms, or on adjacent pavement base of pavement in accordance with the hereinafter specified restrictions on such support. Use of the machine will not be required where the steepness of slope precludes the practical use thereof. Vibrators independent from the self-propelled machine shall not rest on the side forms.

Concrete curb constructed monolithic with concrete pavement will not be included for payment under a Bid Item for concrete pavement. No additional payment will be made for monolithic construction.

216.02 SUBGRADE.--The adjustment of manhole frames and other castings and the preparation of subgrade shall be as specified in Sections 202 and 204, respectively.

216.03 SIDE FORMS.--Metal side forms shall be constructed in accordance with the requirements of Section 215.03, and the other provisions of such Section shall be complied with.

216.04 CONCRETE.--Concrete for concrete pavement shall be Class "C-1" in accordance with the requirements of Section 900, except that when construction is monolithic with curb the concrete shall be Class "B".

The Contractor, at his option, to accelerate setting of the concrete, may use the admixture of 2 pounds calcium chloride per sack of cement, in accordance with the provisions of Section 900.08, except the use of calcium chloride will not be allowed in construction monolithic with curb.

216.05 PLACING CONCRETE.--Placing concrete shall be as specified in Section 215.05.

216.06 FINISHING.--The concrete shall be finished with a rigid straight edge float, not more than 18 feet, or less than 16 feet, in length, having a smoothing surface from 8 to 10 inches in width. The straight edge float shall be operated from bridges with its length parallel to the centerline of the pavement, and shall be dragged with a combined longitudinal and transverse motion, planing off the high places and filling in depressions.

The surface shall then be floated with a light wood float of the same length as the aforementioned rigid float, but from 6 to 8 inches in width and 1/2 to one inch in thickness, and equipped with reversible handles at each end. The light wood float shall be operated from bridges with its length parallel to the centerline of the pavement, and shall be dragged transversely across the pavement with its forward edge raised slightly so the smoothing will be done by the back edge.

Immediately following the float finishing, the surface shall be brushed transversely across the pavement with a bristle brush to produce a uniform, nonskid texture. The brushes shall be maintained clean and free from encrusted mortar. Brushes that cannot be cleaned shall be discarded. The brushing shall not be done until the concrete has become slightly sticky. This will require the finishers to remain on the work for a considerable length of time after the spreading so that the concrete will have sufficiently set before being given the final finish.

The finished pavement shall be to the required grade and cross section, and shall not vary from the required surface more than 1/8 inch in 10 feet.

216.07 CONSTRUCTION JOINTS. —The location and forming of construction joints shall be in accordance with the requirements therefor specified in Section 215.06. The concrete shall in no case be edged.

Where concrete pavement base will be poured against concrete parking strip or gutter, the Contractor shall construct the required keyway in such pavement, parking strip or gutter. The longitudinal centerline of the keyway shall be one inch below the horizontal centerline of the vertical face in which it is formed.

216.08 DUMMY JOINTS. —Transverse dummy joints shall be placed at 15 feet on centers, for the full width of the pavement, in alignment with the joints of adjacent concrete pours, and at right angles to the center line of the street. On curves they shall be constructed on radial lines.

Dummy joints shall be as specified in Section 215.07, shall under no circumstance be edged, and shall be continuous over the insert.

Expansion joints shall not be constructed in concrete pavement.

216.09 PROTECTION AND CURING. —Concrete pavement shall be protected and cured in accordance with the requirements of Section 900.16

No equipment, or public or other traffic shall be allowed on concrete pavement until ten (10) days after the pavement has been placed, except that when calcium chloride is used in accordance with the requirements of Section 900.08 as an admixture to accelerate the setting of concrete, public traffic may be allowed thereon only after at least twenty-four (24) hours have elapsed since the completion of all placement of such concrete.

216.10 PAYMENT. —Concrete pavement of the specified thickness, satisfactorily constructed, complete in place, as specified, will be

paid for at the price bid per square foot, measured horizontally.

Concrete pavement constructed adjoining curb will be measured from the face of curb at a depth of 6 inches below the top of curb, irrespective of the actual depth.

The areas of boxed-out locations for manhole and other castings and facilities, regardless of ownership thereof, will not be deducted from the areas of concrete pavement for which payment will be made.

## Section 217

### Raised Traffic Bars

217.01 GENERAL.—The Contractor shall fabricate and install raised traffic bars of the dimensions shown, complete in place, and shall clean and place adhesive on, the pavement in preparation therefor, all where shown on the plans or directed, and including Incidental Work. The bars shall be of Class "B" concrete, except with a maximum slump of 3 inches, made with white Portland cement, and may be precast, cast in place, or extruded, at the option of the Contractor. Approved substitute aggregate materials may be used.

217.02 TESTING.—When required by the Engineer raised bars will be tested in the City's laboratory at no cost to the Contractor. After curing, each bar shall be capable of supporting a minimum load of 400 pounds when tested as a simple beam with the base in tension on roller supports at 20-inch centers and loaded at midspan through a saddle one inch wide shaped to conform to the contour of the bar. The load shall be applied at a uniform rate or in increments not in excess of 50 pounds. Further, the compressive strength shall be 1000 pounds per square inch minimum.

The Contractor shall furnish at least one group of 3 test bars, each 32 inches in length, for each 200-linear feet, or fraction thereof, of raised bars constructed.

217.03 INSTALLATION.--Raised bars shall be placed, cast or extruded, on the finished pavement with an adhesive consisting of polyvinyl acetate emulsion, asphaltic emulsion, or approved equal. If asphaltic emulsion is used, no clay or similar substances shall be used in its manufacture as emulsifying or stabilizing agents. The adhesive shall be of a consistency suitable for heavy trowel application at atmospheric temperature. It shall develop a tenacious bond on setting. Before placing the adhesive, the surface of the pavement shall be cleaned free of dust, loose material or oil. The adhesive shall be applied in such quantity that a firm, uniform bearing is obtained throughout the area of contact. Excess adhesive shall be squeezed from under the bar and the excess shall be removed. When bars are placed over a joint or crack, an open joint shall be made through the bars.

At the conclusion of all other work in the area, the bars shall be painted with one (1) coat of white traffic lacquer, or approved equal, applied in accordance with the manufacturer's recommendations. Adequate precautions shall be taken, and, upon completion of the painting, adjacent and other pavements shall have on them no paint or discoloration caused thereby.

217.04 PAYMENT.—Raised traffic bars, satisfactorily fabricated and installed as specified, will be paid for at the price bid per linear foot of adhered bar, measured horizontally along the longitudinal centerline thereof.

## Section 218

### Asphalt Concrete Base

218.01 GENERAL.—The Contractor shall construct asphalt concrete base, 6 inches thick unless otherwise specified, consisting of asphalt and graded mineral aggregate proportioned and mixed at a central mixing plant, and spread and compacted to the lines, grades, cross sections and thicknesses shown on the plans, or where directed, including preparing the subgrade, furnishing and applying paint binder, and doing all other necessary or required Incidental Work.

218.02 ASPHALT.—Asphalt shall be Grade 60-70 steam refined paving asphalt, in accordance with all current applicable requirements and specifications of the Asphalt Institute and the Uniform Pacific Coast Specifications for Paving Asphalt. The amount thereof to be used shall be between 4 and 5.5 percent by weight of the dry mineral aggregate.

A test report shall be furnished in accordance with the requirements of Section 220.02.

218.03 AGGREGATE.—Mineral aggregate shall be in accordance with the quality requirements set forth in Section 220.03.

The combined dry mineral aggregate shall have a particle size distribution such that the percentage composition by weight, determined by test using standard sieves of square mesh wire construction, will be in accordance with the following grading requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
1-1/4" . . . . .	100
1" . . . . .	95-100
3/4" . . . . .	80-95
3/8" . . . . .	50-65
No. 4 . . . . .	35-50
No. 8 . . . . .	23-33
No. 30 . . . . .	12-22
No. 200 . . . . .	1-5

218.04 PROPORTIONING AND MIXING.—The mineral aggregate shall be prepared and proportioned, and mixed with the asphalt, as specified in Section 220.04.

218.05 SUBGRADE.—Before placing asphalt concrete base, the subgrade shall be prepared as provided in Section 204, except that in all cases where the area to be paved is composed of sand, or where a suitable unyielding support for the pavement cannot otherwise be provided, there shall be constructed a compacted subbase of untreated rock, 6 inches thick conforming to the provisions of Section 213, the subgrade for which shall have been prepared as required in Section 204.

218.06 PAINT BINDER.—Paint binder, mixing type asphaltic emulsion, SS-1, shall be furnished and applied as specified in Section 220.05.

218.07 SPREADING EQUIPMENT AND SPREADING.—Spreading, and equipment therefor, shall be in accordance with the requirements of Sections 220.06 and 220.07 supplemented as follows: Unless the specified thickness of the base after compacting is less than 4 inches, the base shall be spread and compacted in two courses, each in the manner specified.

No asphalt concrete base shall be spread when the temperature is below 50° Fahrenheit or when the subgrade is wet.

218.08 COMPACTION.—Immediately after the base has been spread it shall be compacted with power rollers in first-class mechanical condition. Roller sprinkler systems shall operate satisfactorily in all respects.

The Contractor shall furnish and use, for each asphalt paver furnished, a minimum of two (2) rollers of the types and employed as follows:

- 1) Initial or breakdown rolling shall consist of one (1) complete coverage with a steel-tired three-axle tandem, two-axle tandem or three-wheel roller, weighing not less than 12 tons, operating with the drive wheel toward the paver.
- 2) Final rolling shall follow the initial or breakdown rolling and shall consist of three (3) complete coverages with a pneumatic-tired roller while the temperature of the mixture is at or above 150° F.

The pneumatic-tired roller shall be the oscillating type having a width of not less than 4 feet and equipped with pneumatic tires of equal size and diameter. Wobble-wheel rollers will not be permitted. The tires shall be so spaced that the gap between adjacent tires will be covered by the tread of the following tire.

The tires shall be inflated to 90 pounds per square inch or such lower pressure designated by the Engineer, and maintained so that the air pressure will not vary more than 5

pounds per square inch from the designated pressure. The roller shall be so constructed that its total weight can be varied to produce an operating weight per tire of not less than 2000 pounds. The total operating weight of the roller shall be varied as directed by the Engineer.

When the total amount of asphalt concrete base included in the contract is 1000 tons or less, rolling may be in accordance with the following alternative requirements:

The Contractor shall furnish and use a minimum of one steel-tired 2-axle tandem roller, weighing not less than 8 tons, provided it is demonstrated to the satisfaction of the Engineer that such a roller can perform the work.

Rolling shall consist of sufficient coverages to produce a surface thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities.

Restricted areas inaccessible to power rollers may be compacted by rolling with the wheels of a loaded truck of not less than 5 tons capacity, or by hot tampers.

218.09 PAYMENT.—Asphalt concrete base of the specified thickness, satisfactorily constructed, complete in place as specified, will be paid for at the price bid per square foot, measured horizontally.

The areas of boxed-out locations for manhole and other castings, regardless of ownership thereof, will not be deducted from the areas of asphalt concrete base for which payment will be made.

## Section 219

### Asphalt Concrete Leveling Course - Temporary Pavement

219.01 GENERAL.—The Contractor shall construct asphalt concrete leveling course and temporary pavement, except as noted hereinafter, each consisting of asphalt and graded mineral aggregate proportioned and mixed at a central mixing plant and spread and compacted to the lines, grades, cross sections and thicknesses shown on the plans, or where directed, including cleaning existing pavement or preparing the subgrade, as the case may be, furnishing and applying paint binder for leveling course, and doing all other necessary or required Incidental Work.

The hereinbefore specified temporary pavement will not be required for temporary patches over trenches and other areas less than 500-square feet in area, but in lieu thereof, at the option of the Contractor, may be paved with 1-1/2 inches minimum thickness of a homogeneous mixture of paving asphalt, cut back oil or solvent, and suitable aggregate, which when compacted will provide a smooth and satisfactory roadway surface.

219.02 ASPHALT.—Asphalt shall be Grade 60-70 steam refined paving asphalt, in accordance with all current applicable requirements and specifications of the Asphalt Institute, and the Uniform Pacific Coast Specifications for Paving Asphalt. The amount thereof to be used shall be between 4 and 6 percent by weight of the dry mineral aggregate.

A test report, in the case of asphalt furnished for leveling course, shall be furnished in accordance with the requirements of Section 220.02.

219.03 AGGREGATE.—Mineral aggregate shall be in accordance with the requirements for 3/4" Max. of Section 220.03.

219.04 PROPORTIONING AND MIXING.—The mineral aggregate shall be prepared and proportioned, and mixed with the asphalt, as specified in Section 220.04.

219.05 PAINT BINDER.—Paint binder, mixing type asphaltic emulsion, SS-1, shall be furnished and applied as specified in Section 220.05.

Paint binder will not be required for temporary pavement.

219.06 SPREADING EQUIPMENT AND SPREADING.—Spreading, and equipment therefor, shall be in accordance with the requirements of Sections 220.06 and 220.07 supplemented as follows: Unless the specified thickness of the base after compacting is less than 4 inches, the base shall be spread and compacted in two courses, each in the manner specified.

No asphalt concrete leveling course shall be laid when the temperature is below 50° Fahrenheit, or in other unsuitable weather, or when the subgrade is wet.

219.07 COMPACTION OF LEVELING COURSE.—Leveling course shall be compacted in accordance with the requirements of Section 218.08.

219.08 COMPACTION OF TEMPORARY PAVEMENT.—Before placing the temporary pavement, the subgrade therefor shall be brought to a reasonably smooth and compacted surface, as determined by the Engineer, then very lightly sprinkled with water to lay the dust.

Paint binder will not be required for temporary pavement.

Temporary wearing surface shall be compacted by light rolling, and tamped sufficiently at the edge of the adjacent pavement, to assure the safe and smooth riding of vehicles. Additional temporary wearing surface material shall be placed as necessary for maintenance and patching.

Disposal of excavated and removed temporary pavement shall be in accordance with the requirements of Section 108.11.

**219.09 CERTIFICATES OF WEIGHT.**—Certificates of weight shall be furnished to the Engineer in accordance with the requirements of Section 110.02.

**219.10 PAYMENT.**—Asphalt concrete leveling course satisfactorily constructed, complete, in place, as specified, will be paid for at the price bid per ton.

Temporary pavement shall be done as Incidental Work.

If the Proposal includes a Bid Item for temporary pavement, all specified or shown temporary pavement construction will be of the same materials as specified for leveling course, and will be paid for at the price bid per ton.

"Cut-back" asphalt concrete temporary pavement, in all cases, shall be furnished and placed as Incidental Work.

All satisfactorily completed temporary and permanent asphalt concrete leveling course constructed in conjunction with the setting and resetting, as the case may be, of castings and, in accordance with the requirements of Section 202, specified to be done by the Contractor, will be paid for under the Bid Item for asphalt concrete leveling course.

## Section 220

### Asphalt Concrete Wearing Surface

**220.01 GENERAL.**—The Contractor shall construct asphalt concrete wearing surface, 2 inches thick unless otherwise specified, consisting of asphalt and graded mineral aggregate, proportioned and mixed at a central mixing plant, and spread and compacted to the lines, grades, cross sections and thicknesses shown on the plans, or where directed, including cleaning the area to be paved, furnishing and installing paint binder, and doing all other necessary or required Incidental Work.

Asphalt concrete types are designated by the maximum size particle in the constituent graded aggregate. In general, use shall be as follows: 3/4" Max. on new pavement base, 1/2" Max. for resurfacing and for conform pavement, and 3/8" Max. (open graded) when the total compacted thickness to be placed is less than 1-1/2 inches.

Asphalt concrete specified to be used to construct asphalt concrete curb, sidewalk and dike, if the Proposal contains a Bid Item for asphalt concrete wearing surface, will be included in the quantity thereof for which payment will be made.

#### **220.02 ASPHALT**

**General.**—Asphalt shall be Grade 60-70 steam refined paving asphalt, in accordance with all current applicable requirements and specifications of the Asphalt Institute, and the Uniform Pacific Coast Specifications for Paving Asphalts. The amount thereof to be used for the three mix types, in percent by weight of the dry aggregate, shall be:

3/4" Max. and 1/2" Max. . . . .	4 to 6
3/8" Max. (open graded). . . . .	3.5 to 5

Test Report.—A test report shall be furnished in duplicate by the manufacturer at the time of shipment of the asphalt for each project or separately laid part thereof. The report shall show the shipment number, dates of shipment, contract and purchase order number, quantity, and the results of the tests set forth in the Asphalt Institute and Uniform Pacific Coast specifications for paving asphalts.

### 220.03 AGGREGATE

General.—Aggregate for asphalt concrete surface course mixes shall consist of a mixture of coarse and fine aggregates, which shall be clean, hard, durable material, free from decomposed materials, vegetable matter and other deleterious substances.

Coarse aggregate is material retained on the No. 4 sieve and fine aggregate is material passing the No. 4 sieve.

The combined dry mineral aggregate shall consist of material of which at least 60 percent by weight shall be crushed particles as determined by Test Method No. Calif. 205.

Grading.—The combined dry mineral aggregate shall have a particle size distribution such that the percentage composition by weight, determined by test using standard sieves of square mesh wire construction, immediately prior to mixing with asphalt binder, will be in accordance with one of the grading requirements set forth as follows:

SURFACE COURSE AGGREGATE GRADING REQUIREMENTS			
Percentage Passing			
Sieve Sizes	3/4" Max.	1/2" Max.	3/8" Max. (open graded)
1" . . . . .	100	---	---
3/4" . . . . .	95-100	100	---
1/2" . . . . .	---	95-100	100
3/8" . . . . .	60-75	75-90	90-100
1/4" . . . . .	---	---	55-75
No. 4 . . . . .	40-55	50-67	30-50
No. 8 . . . . .	27-40	35-50	15-32
No. 16 . . . . .	---	---	0-15
No. 30 . . . . .	12-22	15-30	---
No. 200 . . . . .	3-6	4-7	0-3

The gradings specified hereinbefore are based on materials of a uniform specific gravity. Correction of grading limits shall be made to compensate for difference in specific gravity of 0.2 or more between portions of the aggregate.

The combined gradings within the specified limits shall be of such uniformity that the materials during any day's run will not vary more than the following:

Maximum range in the percentage of material passing No. 4 sieve. . . . .	6
Maximum range in the percentage of material passing No. 30 sieve . . . . .	5

Tests.—The combined aggregate shall also conform to the following quality requirements immediately prior to mixing with asphalt binder:

<u>Tests</u>	<u>Test Method No. Calif.</u>	<u>Requirements</u>
Loss in Los Angeles rattler (after 500 revolutions). . . . .	211	50% Max.
Both Kc and Kf-Factors (obtained from Centrifuge Kerosene Equiv- alent Test) . . . . .	303	1.7 Max.
Sand Equivalent . . . . .	217	45 Min.

The combined aggregate mixed with the required percent of asphalt shall also conform to the following quality requirements:

<u>Tests</u>	<u>Test Method No. Calif.</u>	<u>Requirements</u>
Stabilometer Value* . . . . .	304	35 Min.
Moisture Vapor Susceptability (Stabilometer Value). . . . .	307	25 Min.
Swell . . . . .	305	0.030" Max.

\*When the 3/8" Max. aggregate grading is specified for use, the above Stabilometer Value requirement will be 30 Min.

The exact proportions of aggregate and amount of asphalt binder shall be subject to control by the Engineer and may be varied within the limits set forth in order to produce a satisfactory mix.

In general, within the grading limits, a higher content of material passing the No. 200 sieve will require an amount of asphalt binder closer to the upper limit.

220.04 PROPORTIONING AND MIXING.--The mineral aggregates and asphalt binder shall be mixed at a central mixing plant. The aggregates and asphalt binder may be proportioned either by weight or by volume.

Aggregate shall be stored, dried, heated and proportioned in a manner that will give a combined grading within the specified grading limits and satisfactory to the Engineer.

Drying shall continue for a sufficient time and at a sufficiently high temperature to reduce the average moisture content so that at the completion of mixing operations and also at the time of spreading the mixture, the amount of moisture in the mixture shall not exceed one percent.

The drier shall be provided with a heat indicating device in order that the temperature of the aggregate leaving the drier may be determined. The heat indicating device shall be accurate to the nearest  $10^{\circ}$  F., and shall be installed in such a manner that a fluctuation of  $10^{\circ}$  F. in the aggregate temperature will be shown by the heat indicating device within one minute.

Any evidence of segregation, degradation, or improper combining of aggregate will be cause for rejection of the asphalt concrete containing such aggregate.

Uniformity of distribution of asphalt will be determined by extraction tests in accordance with Test Methods Nos. Calif. 309 or 310. The pounds of asphalt per 100 pounds of dry aggregates shall not vary by more than 5 percent above or 10 percent below the amount designated by the Engineer. This requirement shall apply to samples taken from a single batch, successive batches, at different locations in the plant, or at any location or operation designated by the Engineer.

Paving asphalt used as binder shall be added to the aggregate at a temperature of not less than  $275^{\circ}$  F., nor more than  $375^{\circ}$  F.

When paving asphalt is used as a binder, the temperature of the aggregates at the time of adding the binder shall not be less than  $250^{\circ}$  F., nor more than  $325^{\circ}$  F.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced. In general, the time of mixing shall not be less than 30 seconds, except that the time may be reduced when in the opinion of the Engineer the sizes of aggregate are uniformly distributed and all particles are thoroughly and uniformly coated with asphalt binder.

#### 220.05 PAINT BINDER

General.—Paint binder shall be applied to all surfaces on or against which an asphalt concrete course is to be laid, except a preceding asphaltic course of the same pavement laid within the preceding 24 hours, or except temporary pavement.

Paint binder shall be emulsified asphalt Type SS-1 in accordance with the Asphalt Institute Specifications, except that paint binder applied to concrete base shall be paving asphalt Grade 60-70 in accordance with the requirements of Section 220.02.

A test report, if requested by the Engineer, shall be furnished in accordance with the requirements of Section 220.02.

Applying.—Before applying paint binder the Contractor shall prepare the existing surfaces by power brooming to remove all loose particles, sand, dust, and other foreign materials.

Paint binder shall be applied at the rate of 0.15 gallons per square yard by means of a vehicle-mounted pressure-operated, sprayer-type distributor which shall operate at a continuous, even pressure of not less than 20 pounds per square inch.

Paint binder shall not be applied during cold or rainy weather.

Emulsified asphalt or paving asphalt, as applicable, shall be applied at temperatures suitable for uniform and effective binder coat.

Should, from any cause, an excess of the paint binder be applied, that excess shall be immediately removed. Paint binder shall be applied by spraying, and not in any other manner.

Paint binder shall be applied to all vertical surfaces of pavements, curbs, gutters, and manhole and catchbasin frames against which asphalt concrete materials are to be placed.

Curbs, sidewalks, and gutters shall be protected from paint binder. Any emulsified asphalt sprayed on adjoining improvements shall be immediately cleaned off.

220.06 SPREADING EQUIPMENT.—Asphalt pavers shall be self-propelled mechanical spreading and finishing equipment, provided with a screed or strike-off assembly capable of distributing the material to not less than the full width of a traffic lane. Screed action shall include any cutting, crowding or other practical action which is effective on the mixture without tearing, shoving or gouging, and which produces a surface texture of uniform appearance. The screed shall be adjustable to the required section and thickness. The paver shall be provided with either a full width roller or tamper or other suitable compacting devices. Pavers that leave ridges, indentations or other marks in the surface that cannot be eliminated by rolling or prevented by adjustment in operation shall not be used.

The asphalt paver shall operate independently of the vehicle being unloaded or shall be capable of propelling the vehicle being unloaded in a satisfactory manner and, if necessary, the load of the haul vehicle shall be limited to that which will insure satisfactory spreading. While being unloaded, the haul vehicle shall be in contact with the machine at all times and the brakes on the haul vehicle shall not be depended upon to obtain contact between the vehicle and the machine.

220.07 SPREADING.—All mixtures, except open graded mixture, shall be spread at a temperature of not less than 225° F. and all initial rolling or tamping shall be performed when the temperature of the mixture is such that the sum of the air temperature plus the temperature of the mixture is between 300° F. and 375° F. Open graded mixture shall be spread at a temperature not less than 200° F. and not more than 250° F., unless a higher temperature is directed by the Engineer.

If the temperature of any mixture leaving the plant drops more than 20° F. between the time of leaving the plant and placing, the Contractor shall furnish and use tarpaulins to cover all loads.

Open graded mixtures shall be placed only when the atmospheric temperature is above 60° F. and all other mixtures shall be placed only when the atmospheric temperature is above 40° F.

All layers shall be spread with an asphalt paver as specified in Section 220.06. Asphalt pavers shall be operated in such a manner as to insure continuous and uniform movement of the paver. Segregation shall be avoided and the surfacing shall be free from pockets of coarse or fine material.

Before placing asphalt concrete wearing surface adjacent to cold transverse construction joints, such joints shall be trimmed to a vertical face in a neat line. The location of the proposed joint shall be tested with a 10-foot straightedge and cut back so that when the straightedge is laid on the finished surface parallel with the center-line of the street, the surface shall in no place vary from the lower edge of the straightedge more than 1/8 inch.

Before placing asphalt concrete adjacent to any existing asphalt concrete, the face of the existing asphalt concrete shall be trimmed to a vertical face in a neat line.

Where asphalt concrete wearing surface is placed adjacent to a Portlant cement concrete gutter or parking strip, the asphalt concrete wearing surface shall be so spread that its surface, after compaction, will be approximately 1/4 inch above the surface of the adjacent concrete.

The maximum depth of wearing surface which may be spread and rolled in one course shall not exceed a compacted thickness of 2 inches. Where such thickness exceeds 2 inches, it shall be spread and rolled in courses each not to exceed a compacted thickness of 1-1/2 inches unless otherwise specified in the Special Provisions.

The completed mixture shall be deposited at a uniform quantity per linear foot, which quantity will provide the required compacted thickness without resorting to spotting, picking-up or otherwise shifting the mixture.

Longitudinal joints in the top course shall correspond with the edges of proposed traffic lanes.

At locations where the asphalt concrete is to be placed over areas inaccessible to spreading and rolling equipment, the asphalt concrete shall be spread by any means to obtain the specified results and shall be thoroughly compacted to the lines, grades and cross sections by means of pneumatic tampers, or by other methods that will produce the same degree of compaction as pneumatic tampers.

**220.08 COMPACTION.** —Immediately after the wearing surface has been spread it shall be compacted with power rollers in first-class mechanical condition. Roller sprinkler systems shall operate satisfactorily in all respects.

After the first pass of the roller, any low or grainy spots shall be broken up and more material worked in to insure a surface of uniform texture and maximum density.

The Contractor shall furnish and use, for each asphalt paver furnished, a minimum of three (3) rollers, of the types, and employed as follows:

- 1) Initial or breakdown rolling shall consist of one (1) complete coverage with a steel-tired three-axle tandem, two-axle tandem, or three-wheel roller, weighing not less than 12 tons, operating with the drive wheel toward the paver.
- 2) Intermediate rolling shall follow the initial or breakdown rolling and shall consist of three (3) complete coverages with a pneumatic-tired roller while the temperature of the mixture

is at or above 150° F.

The pneumatic-tired roller shall be the oscillating type having a width of not less than 4 feet and equipped with pneumatic tires of equal size and diameter. Wobble-wheel rollers will not be permitted. The tires shall be so spaced that the gap between adjacent tires will be covered by the tread of the following tire.

The tires shall be inflated to 90 pounds per square inch or such lower pressure designated by the Engineer, and maintained so that the air pressure will not vary more than 5 pounds per square inch from the designated pressure. The roller shall be so constructed that its total weight can be varied to produce an operating weight per tire of not less than 2,000 pounds. The total operating weight of the roller shall be varied as directed by the Engineer.

- 3) Final rolling shall immediately follow intermediate rolling and shall consist of sufficient coverages with a steel-tired two-axle tandem roller, weighing not less than 8 tons, to produce a surface thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities.

When the total amount of asphalt concrete wearing surface included in the contract is 1,000 tons or less, rolling may be in accordance with the following alternative requirements:

The Contractor shall furnish and use a minimum of one steel-tired 2-axle tandem roller, weighing not less than 8 tons, provided it is demonstrated to the satisfaction of the Engineer that such roller can perform the work.

Rolling shall consist of sufficient coverages to produce a surface thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities.

Areas inaccessible to power rollers shall be compacted with hot tampers.

The finished surface of the pavement shall be true to grade and cross section, free from high spots, depressions, or grainy spots, and shall show a uniform distribution of aggregate. A straightedge 10 feet long laid on the finished surface parallel to the centerline of the pavement shall disclose no irregularity in the surface of more than 1/8 of an inch.

**220.09 CONFORM AREAS.**--Conforms shall, where possible, be made along straight or regular lines carefully located to assure a smooth surface and proper crown.

All edges of existing pavement along a trench or butt conform shall be painted with paint binder before depositing asphalt concrete. In areas of the standard butt conform a wedge shaped course, as shown on the plans, shall be laid prior to 4 p.m. of the same day the wearing surface is removed. The new wearing surface shall be placed with the finishing machine within two days of the placing of the wedge.

The asphalt concrete wearing surface shall be spread evenly at

the trench or butt conform, to a thickness of at least 1/4 inch above the existing pavement to insure proper rolling and compaction. After the first pass of the roller all low or grainy spots shall be broken up with a hot rake and more material worked in to bring the surface up to the proper level and insure uniform texture and maximum density.

Other conform consisting of asphalt concrete wearing surface placed on areas prepared with paint binder shall be used as a variable thickness pavement course to adjust the surface of existing pavement to the surface of new pavement, or where shown on the plans or directed by the Engineer.

The limit of the paint binder on the existing pavement shall parallel, and shall project 6 inches beyond, the conform line. The conform pavement shall be raked back to a depth of 1/4 inch to 3/8 inch before rolling.

Particular care shall be taken in the work adjacent to the conform line, where the conform pavement is to be less than 1-inch thick. The existing surface shall be well cleaned and the paint binder properly applied. Very hot hand irons shall be used to smooth the edge of the conform, soften the existing surface and insure a good bond between the new and old materials.

If the Proposal contains a Bid Item for asphalt concrete wearing surface, that used in conform areas will be included in the quantity thereof for which payment will be made.

220.10 AT CASTINGS. --Temporary and permanent asphalt concrete wearing surface constructed in conjunction with setting or resetting, as the case may be, of castings, and in accordance with the requirements of Section 202, specified to be done by the Contractor, if the Proposal contains a Bid Item for asphalt concrete wearing surface, will be included in the quantity thereof for which payment will be made.

Volumes used to determine weights of temporary wearing surface for payment will be determined by measurements, in place, of the boxed-out areas at the castings.

220.11 CERTIFICATES OF WEIGHT. --Certificates of weight for asphalt concrete wearing surface shall be furnished to the Engineer in accordance with the requirements of Section 110.02.

220.12 PAYMENT. --Asphalt concrete wearing surface satisfactorily constructed, in place, as specified, will be paid for at the price bid per ton.

All satisfactorily completed temporary and permanent asphalt concrete wearing surface constructed in conjunction with the setting and resetting, as the case may be, of castings, and, in accordance with the requirements of Section 202, specified to be done by the Contractor, will be paid for under the Bid Item for asphalt concrete wearing surface.

Asphalt concrete wearing surface constructed over and around areas of excavation required under the contract for sewer, drainage, AWSS, electrical and other facilities will not be excluded from payment as

specified in Section 224, but will be paid for under a Bid Item for asphalt concrete wearing surface, regardless of whether such sewers and other facilities are within, or are outside of, the limits for the construction of asphalt concrete wearing surface shown on the plans.

## Section 221

### Seal Coat

**221.01 GENERAL.**—The Contractor shall construct, including doing all necessary or required Incidental Work, emulsified asphalt seal coat on roadway or other surfaces shown on the plans, or where directed, and in accordance with the requirements set forth herein.

The seal coat shall consist of two applications of emulsified asphalt and screenings as follows:

<u>Size of Screenings</u>	<u>Rate of Application Per Square Yard</u>	
	<u>Screenings</u>	<u>Emulsified Asphalt</u>
	<u>(Pounds)</u>	<u>(Gallons)</u>
1st Application 1/2" to No. 4	25	0.30
2nd Application 1/4" to No. 10	15	0.15

**221.02 MATERIALS.**—Emulsified asphalt shall be type RS-2, conforming to the provisions of the Asphalt Institute Specifications. A test report, if requested by the Engineer, shall be furnished in accordance with the requirements of Section 220.02.

Screenings shall consist of broken stone, crushed gravel, or both, shall be hard, tough, durable and sound, and shall be in accordance with the quality requirements set forth in Section 220.03. At least 90 percent by weight of the screenings shall have fractured faces.

Screenings shall be clean, free from deleterious materials, and shall be graded as follows:

<u>Sieve Size</u>	<u>Percentage by Weight Passing Sieves</u>	
	<u>1/2" to No. 4</u>	<u>1/4" to No. 10</u>
3/4" .....	100	100
1/2" .....	90-100	100
3/8" .....	50-80	100
No. 3 .....	10-45	90-100
No. 4 .....	0-15	60-85
No. 8 .....	0-5	0-25
No. 16 .....	—	0-5
No. 30 .....	—	—
No. 200 .....	0-2	0-2

221.03 SURFACE PREPARATION. --Immediately before applying the emulsified asphalt, the surface to be sealed shall be cleaned of all dirt and loose material.

When seal coats are to be applied to rock base or other untreated material, a prime coat of the type specified in the Special Provisions shall be applied to the material in place at a rate of from 0.20 to 0.33 gallon per square yard, as specified.

221.04 APPLYING EMULSIFIED ASPHALT. --Emulsified asphalt shall be applied by means of a vehicle-mounted, pressure-operated, sprayer-type distributor which shall operate at a continuous, even pressure of not less than 20 pounds per square inch at a specified rate of application. The distributor shall be equipped with an accurate pressure gauge that can be easily read by a person walking alongside the distributor vehicle.

The distributor system shall be capable of being operated at any width of application less than the maximum width by shutting off individual sprayer nozzles.

In order to secure uniform distribution, the flow of emulsified asphalt shall be halted before the rate of flow decreases due to depletion of the emulsion supply tank. After the supply tank has been refilled, the specified application rate shall be attained at the sprayer nozzles before resuming application. This shall be accomplished by spreading building paper over the sprayed surface, having the vehicle back up over the paper, commence spraying, and attain the specified rate of application prior to reaching the uncovered, unsprayed surface. The building paper shall be removed from the site by the Contractor as his property.

Emulsified asphalt shall not be applied during cold or rainy weather. No more emulsified asphalt shall be applied to the surface than can be immediately covered with screenings and rolled the same day.

221.05 DISTRIBUTING, SPREADING, AND ROLLING SCREENINGS. --Screenings shall be evenly distributed, immediately following the preceding application of emulsified asphalt, by means of approved spreading devices attached to the rear of the haul vehicles. The haul vehicles shall back up while distributing the screenings so that the wheels will not come in direct contact with the emulsified asphalt. Following each application, the distributed screenings shall be carefully spread and trued up with a suitable blade or a drag broom, or other approved equipment, and all high or low spots shall be corrected by the removal or addition of screenings, as applicable. Each application of screenings shall be rolled once with a power roller weighing not less than 6 tons.

221.06 PAYMENT. --Seal coat, satisfactorily constructed, complete in place, as specified, will be paid for at the price bid per square yard, measured horizontally.

No deduction will be made from the quantity to be paid for on account of castings, or boxed out areas therefor, which exist within the limits of the seal coat.

## Section 222

### Planing Existing Asphalt Concrete Surfaces

**222.01 GENERAL.**—The Contractor, at each area to be planed, shall furnish, operate, on existing asphalt concrete pavement, supply with fuel, maintain, pay all labor costs in connection with, and remove from the site as his property upon the conclusion of use thereof, one or more power-driven road surface heater-planer machines, satisfactorily remove all planed material, and do Incidental Work.

The exact locations to be planed, within or adjacent to the areas shown on the plans or specified in the Special Provisions and except as hereinafter specified the number and depth of cuts, and other factors affecting the work depending on the type of asphalt concrete paving, will be determined in the field by the Engineer and will be subject to possible minor changes as the work progresses.

**222.02 HEATER-PLANER MACHINE.**—The heater-planer machine shall have, in combination, a means for heating and cutting the asphalt concrete roadway surface and blading the displaced material into windrows in one continuous forward motion. The cutting width of the planer shall not be less than 3 feet. The machine shall be of a make and design that has operated successfully on work comparable with that proposed to be done under the contract, shall be operated by experienced operators, and shall cut through the surface material without gouging, shoving, or tearing the pavement. The heating unit need not be mounted in the same machine as the planing unit. The type and size of the machine shall be subject to the approval of the Engineer.

**222.03 CONDUCT OF THE WORK.**—Cuts made with a heater-planer machine shall be of the width, depths, and to the alignment shown on the plans or specified, and shall result in a uniform surface conforming to the required cross section.

The juncture of heater-planed and unplaned areas shall be neat and uniform.

The material planed from the street surface shall be the property of the Contractor and shall be immediately removed by him from the site of the work at his own expense. Any planed material which is deposited on any concrete parking lane shall be immediately removed therefrom by brooming. The removal crew shall follow within 50 feet of the planer unless otherwise directed by the Engineer.

Planing operations shall not be carried on at any time where, in the opinion of the Engineer, weather conditions do not permit efficient operation, or if an open flame is used in the heater, there is danger of igniting entrapped gases from sewers, gas mains or underground gasoline and oil storage tanks. The Contractor, in accordance with the provisions of Sections 102.06 and 105.04, shall be entirely responsible for, and shall hold the City harmless from, any and all damages caused by heat, fire or explosion, or any combination thereof.

Heater-planer operation, in general, will consist of, and for payment be divided into work of, one or more of the following types:

- 1) Operation adjacent and parallel to curb on a linear foot per inch depth of cut basis. If underlying concrete, brick or cobblestone pavement base is exposed before the shown or specified depth of curb is attained, the planing shall be terminated. The resulting cut shall be 7 feet wide and wedge-shaped in section.

The quantity to be paid for on this basis will be computed by multiplying the depth of cut at the curb in inches, required to be made and made, by the number of linear feet of planing of that depth done. Depth of cut will be counted as each full inch thereof plus any partial inch counted as a full inch.

- 2) Operation of the heater-planer machine adjacent and parallel to curb,  $\frac{3}{4}$ -inch cut, on a linear foot basis. The quantity to be paid for on this basis shall be that, not including as footage any additional passes of the machine, required to make a cut 5 feet wide, a minimum of  $\frac{3}{4}$ -inch deep at the curb, and wedge-shaped in section.

- 3) Operation of the heater-planer machine adjacent and parallel to concrete parking lane or concrete gutter,  $\frac{1}{2}$ -inch cut, on a linear foot basis.

The quantity to be paid for on this basis shall be that, not including as footage any additional passes of the machine, required to make a cut 5 feet wide, a minimum of  $\frac{1}{2}$ -inch deep at the parking lane or gutter, and wedge-shaped in section. Asphaltic pavement which has crawled over existing concrete parking lanes and gutters shall be removed as Incidental Work.

- 4) Operation of the heater-planer machine adjacent and parallel to street railway tracks,  $\frac{1}{2}$ -inch cut, on a linear foot basis. The quantity to be paid for on this basis shall be that, not including as footage any additional passes of the machine, required to make a cut 5 feet wide, a minimum of  $\frac{1}{2}$ -inch deep on the track side, and wedge-shaped in section.

- 5) Directed operation on an hourly basis. The time for which payment will be made on this basis, will be the aggregate of the periods during which the machine is actually heater planing.

No payment will be made for time required for refueling or for moving the machine between areas to be planed, and such refueling and movement will be considered Incidental Work.

As the work progresses, the Engineer may designate other areas to be heater-planed. The additional locations, number and depth of cuts, the extent to which heater-planing shall be done and the appropriate basis of operation in these areas will be determined by the Engineer.

**222.04 PAYMENT.**—Planing existing asphalt concrete surfaces, satisfactorily done as specified, will be paid for at the appropriate following unit bid prices:

For heater-planing,

- 1) adjacent and parallel to curb, at the price bid per linear foot per inch of depth of cut;
- 2) adjacent and parallel to curb, at the price bid per linear foot, 3/4-inch cut;
- 3) adjacent and parallel to concrete parking lane and concrete gutter, at the price bid per linear foot, 1/2-inch cut;
- 4) adjacent and parallel to street railway tracks, at the price bid per linear foot, 1/2-inch cut;
- 5) at the price bid per hour of directed operation.

## Section 223

### Corrugated Metal Guard Railing

**223.01 GENERAL.**—The Contractor shall construct corrugated metal guard railing consisting of galvanized, straight and precurved corrugated metal railing elements and flared terminal sections mounted on treated timber posts, all complete in place, with hardware, and shall do all related Incidental Work. The railing shall be constructed true to the lines and grades as designated on the plans and in accordance with the directions of the manufacturer, and after erection shall be cleaned and painted.

**223.02 MATERIALS.**—Timber posts shall be S4S, 8 inch x 8 inch x 4 feet 8 inches, No. 1 stress grade or better Douglas fir free of boxed heart, chambered as shown on the plans or specified, and in accordance with the requirements of Section 426.01. The posts shall be pressure treated with pentachlorophenol in accordance with the requirements of Section 427.06 after being surfaced, chamfered and cut to length. The minimum retention of preservative shall be that specified for ground contact.

The steel plate forming the corrugated rail element shall be rolled from steel from which a 2-inch test specimen shall elongate not less than 12 percent.

The plate shall be shaped into a beam not less than 12 inches wide and with two (2) corrugations not less than 3 inches deep. The plate shall not be less than 12 gauge, subject to standard mill tolerances for gauge. The manufacturing tolerance for width and depth shall be minus 1/8 inch and the edges of the rail shall be smooth after fabrication.

The rail shall develop a minimum tensile strength of 50,000 pounds for the rail element and joints. A section of rail freely supported at each end, on 12-foot centers, shall support a concentrated load at the center of 1,400 pounds with a maximum deflection of 4 inches.

The ends of each length of railing shall be fitted with a section, also of 12-gauge metal, extending at least 18 inches beyond the center of the end post, and so formed that its end shall be at least 7 inches back

of the face of the rail.

Along curvilinear alignments, guard rail elements used shall be shop precurved to radii of curvature such that deviation from the alignment shown on the plans will not at any point exceed 2 inches.

Straight elements may be used where the radius of curvature or the alignment is greater than 110 feet.

The hardware for the guard rail shall consist of:

- 1) at each rail to rail splice, eight (8) 5/8-inch x 1  $\frac{1}{4}$ -inch oval shoulder button head splice bolts, and nuts;
- 2) at each rail to terminal section splice, four (4) 5/8-inch x 1  $\frac{1}{4}$ -inch oval shoulder button head splice bolts, and nuts; and
- 3) at each splice, for fastening to timber post, one (1) 5/8-inch x 10  $\frac{1}{2}$ -inch oval shoulder button head post bolt, nut and cut washer.

**223.03 GALVANIZING.**—All guard rail elements, terminal sections, and hardware shall be hot-dip galvanized in accordance with the applicable requirements of Section 907; however, the guard rail elements and terminal sections may be galvanized either before or after fabrication, the total of the weights of the two (2) galvanizing coatings, one (1) on each side of any sheet, element, or section, shall not be less than 2.0 ounces per square foot, and such galvanizing shall be in accordance with the requirements of ASTM "Standard Specifications for Zinc-Coated (Galvanized) Iron or Steel Sheets, Coils, and Cut Lengths," Designation A 93.

**223.04 CONSTRUCTION.**—The height of the guard rail and of the posts above ground shall be as shown on the plans. Posts shall be placed at equal intervals, not to exceed 12 feet 6 inches, measured horizontally between center lines of adjacent posts.

A post shall be installed at each rail splice and at each terminal section splice.

All posts shall be installed vertically.

After the posts are set, the space around them shall be filled with selected earth free from rock. Fill material shall be placed in layers approximately 4 inches thick, and each layer shall be thoroughly watered and tamped in place to hold the posts securely in position.

All metalwork shall be fabricated in the shop, and no punching, cutting, or welding will be permitted in the field. Metal railing shall be installed in accordance with the directions of the manufacturer of the particular railing.

The railing shall be installed in smooth curves and transitions with no abrupt changes in alignment.

The guard railing in the final position shall be rigid and without any loose joints or connections.

Any rail element dented, bent, broken, warped or otherwise damaged, shall be immediately and satisfactorily repaired or replaced, as applicable, by the Contractor at his sole expense.

**223.05 PAINTING.**—After erection, corrugated metal guard railing shall be painted in accordance with the requirements of Section 909.

Galvanized surfaces shall not be brushed with copper sulphate solution. The Contractor shall, however, exercise special care to remove, with solvent, all grease or oil film from galvanized surfaces to be painted.

All surfaces of the rail, including the end sections and all hardware, shall be painted with one (1) coat of an approved galvanized metal primer which shall be allowed to dry thoroughly. Two (2) coats of an approved white enamel shall then be applied to all the above primed surfaces.

Timber posts shall be painted with one (1) coat of an approved wood primer and two (2) coats of an approved fast-drying white finish paint for wood, and at least 4 inches of post painted with all coats shall be below the ground surface.

All exposed surfaces of corrugated metal guard railing that become soiled or damaged before acceptance of the work shall be cleaned or repainted at the Contractor's expense.

**223.06 PAYMENT.**--Corrugated metal guard railing, satisfactorily constructed as specified, will be paid for at the price bid per linear foot measured along the face of straight and precurved corrugated metal elements between extreme ends of each section of railing including terminal sections thereof as constructed.

## Section 224

### Certain Earthwork and Pavement Construction

#### Excluded From Pay Quantities

**224.01 GENERAL.**—Earthwork and the restoring of curb, pavement base and pavement, necessary for constructing, installing, relocating, or removing, structures, and water, sewer, drainage, landscaping, lighting, traffic control, fire alarm, AWSS, and other facilities and appurtenances, will not be included for payment under Bid Items for earthwork, curb, pavement base, and pavement, but shall be done as Incidental Work, except that no reduction will be made in the pay quantities of Bid Items for earthwork, curb, pavement base, and pavement when such work is required for the aforementioned structures and facilities occurring within the shown or specified limits for earthwork, curb, pavement base, and pavement.



## PART III

# SEWERAGE AND DRAINAGE

### Section 300

#### Excavating

300.01 GENERAL. --The Contractor shall do all trenching and excavating necessary, or required, for the proper construction of the sewers, side sewers, culverts, drains, and sewerage and drainage structures and appurtenances included in the work.

Trenches and other excavations shall be made safe and passable by the use of barricades, bridges, and other approved means. Traffic Routing Work shall be done in accordance with Section 109.

In accordance with Section 373 of the Public Works Code there shall be no limitation on the use of labor-saving devices except at the locations specified in Sections 104.04 and 201.08.

Trenches and other excavations shall be sufficiently wide to allow for the proper construction and installation of sewers and sewerage and drainage structures, but shall not exceed such necessary width.

Tunneling or jacking shall not be used unless specified or approved in writing by the Engineer.

300.02 MINIMUM AND MAXIMUM LENGTH OF TRENCH. --The Contractor shall prepare trench subgrade for sewers not less than 30-linear feet in advance of pipe sewer construction.

The Contractor shall not have more than 500-linear feet of sewer trench, other than side sewer or culvert trenches, open at any one time, subject however, to the possible further limitations which may arise because of traffic routing restrictions. Such maximum footage of open sewer trench shall include backfilled but unpaved trench, partially or completely excavated trench, and area from which pavement has been removed for anticipated trench excavation.

300.03 CONCRETE SAW CUTTING REQUIRED. --Where the existing finished pavement surface is concrete, cuts therein between pavements to be removed and those to remain in place shall be made by an approved power-driven pavement cutting saw before any pavement is jackhammered or broken. Saw cuts shall be 2 inches deep, neat, regular, and vertical. The Contractor shall exercise extreme care not to damage the cut edges of the wearing surface. Damaged edges shall be recut to acceptable alignment and vertical surface.

Cuts made in concrete parking strips, gutters, and sidewalks shall be made in accordance with the requirements of Section 201.02.

300.04 EXCAVATIONS TO HAVE VERTICAL SIDES. --All trenches and other excavations in paved and improved areas shall have vertical

sides, and shall be no wider at the top than at the bottom, except as required to accommodate successive lifts of lagging.

300.05 REMOVAL OF SUBSURFACE OBSTACLES. --Subsurface obstacles, regardless of size, shape, or material, and whether or not shown on the plans or specified, if encountered within the limits of required excavation necessary for the work, shall be removed by the Contractor as Incidental Work as set forth in Section 108.05.

300.06 UNSUITABLE SUBGRADE TO BE REPLACED. --If the subgrade material is unsuitable, as determined by the Engineer, such material shall be excavated to the depth and width as the Engineer considers necessary and replaced with suitable material compacted into place.

Removal of unsuitable material and backfilling and compacting with suitable material outside the limits of required excavation necessary for the work will be paid for as Extra Work in accordance with the requirements of Section 111.

300.07 DISPOSAL OF MATERIALS. --The disposal of surplus excavated and other materials, and the salvaging of materials shall be in accordance with Section 108.11.

300.08 PAYMENT. --Excavating, including saw cutting concrete pavement, and disposing of materials, shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **Section 301**

### **Sheet Piling, Lagging and Bracing**

301.01 GENERAL. --The Contractor shall furnish, install, and maintain such sheet piling, lagging, and bracing, as is necessary to support the sides of excavations and any adjacent structures, and to prevent any movement of the ground or danger to life or property.

The manner of bracing excavations shall be in accordance with the rules, orders and regulations of the State of California Division of Industrial Safety.

In excavations where sand or other running material is encountered, placing of the necessary lagging or sheet piling shall commence before a depth of 5 feet is attained, and thereafter such lagging shall be driven or lowered progressively with the excavating in a manner such that the sides of the excavation will be completely covered and adequately supported.

Should any sheet piling, lagging, or bracing which has been installed be in any way insufficient for its purpose, the Contractor shall at once provide additional and adequate materials. The provision of any addi-

tional supports ordered by the Engineer shall in no way relieve the Contractor of his responsibility for the sufficiency of his precautions.

Any voids that exist between the outside surface of the lagging and the adjacent side of the excavation shall be immediately backfilled in accordance with Section 304.

Unless otherwise specified or approved, sheet piling, lagging, and bracing shall be removed during backfilling. Vacancies left by such removal shall be immediately backfilled with acceptable material compacted into place.

Sheet piling and lagging which during withdrawal fails or breaks, or in the opinion of the Engineer is otherwise incapable of being withdrawn, shall be cut off at least 3 feet below pavement subgrade and the upper part removed.

Lagging shall not be used as a surface against which concrete is placed unless permitted in the Special Provisions. Adequate space shall be provided within the limits of the excavation, sheet piling, lagging, or bracing, as the case may be, to allow for proper construction of the structure to the alignment and cross sections shown on the plans. If lagging is used for the outside form, the concrete shall be separated from the lagging by a waterproof membrane, or by other means approved by the Engineer, and any excess width of trench caused by misalignment of the lagging shall be offset by increasing the structure wall thickness. No deviation in the interior alignment or dimensions will be permitted.

301.02 PAYMENT. --Sheet piling, lagging, and bracing shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 302

### Handling and Disposal of Seepage, Storm Water and Sewage

302.01 GENERAL. --The Contractor shall dispose of water from all sources; shall keep excavations dry; shall do all necessary work to suitably and adequately divert all sanitary, ground water, tide water, and storm water flow; and shall furnish all necessary pumps and related equipment; all in accordance with the requirements set forth herein and in Section 108.06.

Subdrains and crushed rock, if constructed, shall be in accordance with Sections 313 and 314.

302.02 SANITARY SEWAGE. --All sanitary sewage shall be carried in closed conduits and will not be allowed to flow exposed on the street, or in gutters, trenches, or excavations. The Contractor may use, to the limit of their capacity, subdrains in accordance with Section 313.

302.03 SUBDRAINS. --Where subdrains are used, side sewers cut along the line of the work shall be temporarily connected to the subdrains by means of pipes and fittings. When permanent side sewer connections are re-established, openings for temporary connections shall be sealed with brickwork or concrete, and the pipe and fittings used for such connections removed from the site by the Contractor as his property.

302.04 DIVERSIONS AND DAMS. --The Contractor shall not obstruct the normal flow in any existing sewer, but where necessary shall divert such flow around or through the work or discharge such flow into other approved sewers or places.

All flow including storm water flow shall be carried around or through the work by the Contractor at his own expense by diverting the flow to other sewers, by pumping or by bypassing the work with pipes or other conduits, unless otherwise specified. All sewage flow, including storm water flow, shall be diverted to sewers leading to treatment plants and shall not be diverted to a sewer leading directly to the Bay or Ocean.

The Contractor shall not construct a dam in any sewer or sewer structure without the prior written consent of the Engineer. Regardless of such consent, the Contractor shall be responsible for any damage resulting from the construction of any dam or dams in the sewerage system. Should the construction of any such dam or dams cause sewage or storm water to back up and flow on private property through side sewers, or by other means, the Contractor shall immediately remove the dam or dams causing the backflow, remove the sewage and storm water from the private property, and clean up and disinfect the premises.

Dams, diversion devices, or other obstructions placed in sewers or manholes for diverting flow during the work, shall be removed by the Contractor when directed by the Engineer. Any damage to sewerage or drainage facilities resulting from the Contractor's handling and disposing of seepage, storm water, and sewage, shall be satisfactorily repaired by the Contractor at his expense.

302.05 PAYMENT. --Handling and disposal of seepage, storm water, and sewage shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 303

### Removal or Abandonment of Sewers and Related Structures

**303.01 GENERAL.** --The Contractor shall remove or abandon sewers and related structures where and as shown on the plans, or where directed, in accordance with these specifications.

Certain records of the existing sewers and structures in the vicinity of the site of the work are on file in the City Engineer's Office, and may be examined by the Bidder. The Bidder should note, however, that these structures may have been altered by repairs at various times and may differ from the records on file, and that no representation is made nor responsibility taken by the City as to the accuracy of the records or the locations shown thereon.

**303.02 REMOVAL.** --Existing sewers, manholes, catchbasins, other sewerage and drainage structures, and appurtenances, except vitrified clay pipe sewers, side sewers and culverts, shown on the plans as abandoned or to be abandoned, shall be removed to a depth of not less than 3 feet below street grade or ground surface, as the case may be. Existing sewers, manholes, catchbasins, other sewerage and drainage structures, and appurtenances, including vitrified clay pipe sewers, side sewers and culverts which have been or are to be abandoned and which lie within a sewer trench or sewer structure excavation, shall be removed from within the limits of required excavation necessary for the work.

Unsuitable subgrade material removed and replaced with suitable material below the required excavation necessary for the work shall be removed and replaced in accordance with Sections 300.06 and 111.

**303.03 ABANDONMENT.** --VCP sewers, side sewers, and culverts to be abandoned but not required to be removed shall be thoroughly sealed at all open ends, and at the structures in which they terminate, as applicable, with brick and mortar or concrete. Upon abandonment, VCP main sewers shall be filled with an approved slurry grout or soil cement mixture. Brick and concrete sewers and appurtenances required to be abandoned but not required to be removed shall be broken open and the contained sewage removed, after which the sewers and appurtenances shall be completely backfilled with sand and thoroughly compacted by saturation with water.

**303.04 SLURRY GROUT AND SOIL CEMENT MIXTURES.** --Abandoned sewer facilities specified to be filled shall be filled with an approved slurry grout or soil cement mixture. Facilities to be filled shall be sealed at the downstream end, filled with the approved mixture, and sealed at the upstream end. Brick and mortar, or concrete, shall be used to seal openings and outlets.

Any damage to existing facilities resulting from the use of a filler

mixture shall be satisfactorily repaired by the Contractor at his own expense and no direct or additional payment will be made therefor.

303.05 PAYMENT. --Sewers and sewer structures satisfactorily removed or abandoned will be paid for at the respective prices bid therefor when such work is specified on the plans or in the Special Provisions and set forth for payment in the Schedule of Bid Prices. Such work specified on the plans or in the Special Provisions and not set forth for payment in the Schedule of Bid Prices shall be done as Incidental Work.

## **Section 304**

### **Backfilling and Restoring Pavement**

304.01 GENERAL. --The Contractor shall do all necessary or required backfilling and restoring of pavement. Backfilling shall not commence until after sewers, culverts, drains, sewerage and drainage structures, and appurtenances have been properly constructed and inspected. Backfill shall be placed in a manner not to disturb, damage, nor subject such facilities to unbalanced loads or forces. Restoring of pavement shall be done in accordance with Section 108.09.

304.02 CONCRETE STRENGTH BEFORE BACKFILLING. --Backfilling over and against sewerage and drainage facilities shall not commence until concrete has attained a compressive strength of 2,000 pounds per square inch and all mortar joints are set sufficiently to prevent damage.

304.03 SAND BED FOR PIPE SEWERS AND CULVERTS. --All pipe sewers and culverts shall be constructed on a prepared or natural sand bed the width of which shall be at least the full width of the pipe, and after installation of the pipe not less than 4 inches thick below the entire pipe, including bells; however, a sand bed will not be required for pipe sewers on concrete foundations, in encasements, or on crushed rock bedding.

304.04 SUBGRADE SURFACES FOR PILE-SUPPORTED CONCRETE. --Subgrade surfaces on which pile-supported concrete is placed shall be adequately prepared to assure proper support for the placed concrete until such concrete has sufficient strength to span and be supported solely by the piles.

304.05 CRUSHED ROCK LAYER IN TRENCH. --Crushed rock shall be furnished and placed where necessary to maintain an appropriately dry trench in accordance with Section 314.

304.06 REQUIRED SAND BACKFILL. --Backfill around all sewers, culverts, and sewerage and drainage structures, from the bottom of the trench to a height 6 inches above the top of such facilities, shall be sand only.

Backfill around manholes and catchbasins shall be sand to a level 6 inches above the supporting structure or adjacent sewer or culvert.

304.07 BACKFILL ABOVE REQUIRED SAND. --Backfill above the required sand shall be approved site excavated or other material free of debris, wood, and other organic or deleterious matter. Lumps, rocks, concrete and excavated pavement will be allowed in the backfill provided that such materials do not exceed 3 inches in the greatest dimension.

304.08 BACKFILL LAYERS. --Each layer of backfill shall be compacted both during placement and following the withdrawal of sheet piling and lagging to the top of the layer being compacted.

Sand backfill shall be flooded or jetted, or compacted by other approved means, in horizontal layers not more than 3-feet thick. Flooding or jetting of sand will be prohibited where sewers or structures might be damaged, or adjacent materials softened, by the applied water.

All backfill other than sand shall be placed in horizontal layers not more than 8 inches thick before compaction, and each layer shall be satisfactorily compacted by mechanical means. Flooding or jetting, in this case, will not be allowed.

In all cases, each layer of backfill material shall be satisfactorily compacted before placing the next layer thereon.

304.09 COMPACTION.--The Term "Relative Compaction," used herein regarding compaction of backfill, is defined as the percentage ratio of the field compacted dry density to the maximum dry density obtainable by compaction at optimum moisture content.

The methods of testing compaction, including determination of optimum moisture content and maximum density, shall be in accordance with ASTM "Standard Methods of Test for Moisture-Density Relations of Soils, using a 10-lb. Rammer and an 18-in. Drop," Designation D 1557.

Compaction tests, as required by the Engineer, on the particular material used will be conducted and evaluated by the City at no cost to the Contractor.

Backfill shall be compacted to the following minimum relative compactions:

- From bottom of trench to top of required sand layer. . . . . .90 percent;
- From top of required sand layer to 3 feet below new or existing pavement subgrade, or adjacent ground, whichever is lower . . . . . .80 percent;
- From 3 feet to one foot below new or existing pavement subgrade, or adjacent ground, whichever is lower . . .90 percent;
- Within one foot of new or existing pavement subgrade, or adjacent ground, whichever is lower . . . . . .95 percent.

Where sewerage and drainage facilities are constructed in roadway construction areas, compaction within roadway embankment and fill shall be in accordance with Section 205.

304.10 PAYMENT. --Backfilling and restoring pavement shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **Section 305**

### **Vitrified Clay Pipe Sewer**

305.01 GENERAL. --The Contractor shall construct vitrified clay pipe sewer (including encasement in reinforced concrete, plain concrete base, or reinforced concrete foundation, as applicable) including all excavating, lagging, backfilling, restoring pavement, and other Incidental Work, necessary or required, for a complete, satisfactory sewer installation, where and as shown on the plans, or where directed.

305.02 PIPE. --Vitrified Clay Pipe (VCP) shall conform to the ASTM "Standard Specifications for Extra Strength Unglazed Clay Pipe," Designation C 278, except as modified by the plans, the Special Provisions and these specifications.

VCP main sewers and fittings shall be of the bell and spigot type.

The minimum thickness of the pipe barrel shall conform to the Regional Western Standard of the Clay Pipe Institute.

305.03 JOINTS. --Bell and Spigot joints shall be constructed with factory-fabricated plastisol gasket compression type joints in accordance with the ASTM "Standard Specification for Vitrified Clay Pipe Joints Using Materials Having Resilient Properties," Designation C 425. Joints shall be made up in the field in accordance with the manufacturer's recommendations. All joints shall be tight fitting, watertight, and without imperfections. Only factory recommended lubricants shall be used.

Joints connecting pipes to structures shall be integrally cast with the structure or made with Class "A" cement mortar. Imperfections of cast joints shall be repaired with Class "A" cement Mortar. Cement mortar shall be in accordance with the requirements of Section 900.09.

305.04 HANDLING AND STORING. --Pipe shall be handled and stored so as to prevent damage thereto, or to existing improvements. Pipe, when stored, shall be properly blocked to prevent rolling.

305.05 CONSTRUCTION. --Pipe sections of the main sewer shall be ordered in short lengths, as necessary, in order that Y-branches or Tees will be located opposite or within 2 feet downstream of existing side sewer locations.

Pipe sewers shall be so constructed and the sections so installed that the sections of pipe laid together form a continuous uniform line of pipe with a smooth regular interior surface. Pipe shall be laid uphill

from structure to structure with the bell end upgrade. Each pipe shall be laid in the proper position, on a firm 4-inch deep sand bed, and shall have uniform support and bearing for its entire length. Bells shall be cleaned before the spigot of the succeeding pipe is inserted. A bell hole shall be dug at the end of each pipe to accommodate the bell and facilitate the making of the joint.

Pipe sewers shall be laid in conformity to the prescribed lines and grades, which shall be obtained for each pipe by measuring from a tightly stretched line running parallel with the grade and supported over the center line of the sewer by bars placed across the trench. The pipe sections shall be tightly fitted together. All adjustments of pipe to line and grade shall be made by scraping away or filling in and tamping the earth under the body of the pipe, not by blocking or wedging up. Supporting blocks shall not be used under the pipe. Pipe shall not be laid on, or against, or within 4 inches of any rock.

Any pipe which has been disturbed shall be taken up, the joints cleaned, and relaid.

The Contractor shall not lay pipe in water and he shall use crushed rock, subdrains, or some other method approved by the Engineer to maintain an appropriately dry trench.

Pipe sewers in encasements or on foundations shall have the bottom reinforcing steel of the encasement or foundation run continuously through all sewerage structures constructed along or at the end of such sewers.

When pipe is being encased in reinforced concrete, the Contractor shall support the pipe during placement of the concrete encasement, shall prevent any "floating" or movement of the pipe, and shall carefully maintain the required line and grade. The support and method thereof shall be approved by the Engineer prior to placing encasement but such approval will not relieve the Contractor of his responsibility for execution of the work so that the pipe will be true in line and grade and satisfactory in every respect.

The unconnected "head end" of main sewers shall be securely closed with a vitrified clay stopper or an approved brick or timber bulkhead before backfilling. The "head end" of such sewers shall be marked by a 2-inch x 2-inch redwood stake running vertically from the bottom of the trench to a point 6 inches below the surface of the ground, pavement, or walk, as applicable.

**305.06 PAYMENT.** — Vitrified clay pipe sewer (including encasement in reinforced concrete, plain concrete base, or reinforced concrete foundation, as applicable) satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the sewer, exclusive of manholes and structures, between the outside surfaces of manholes and structures, or to the limits as constructed if the sewer does not terminate in manholes or structures.

Vitrified clay pipe sewer connecting to a manhole or structure by a collar or boss shall be measured to the outside surface of such collar or boss at the point of connection with the pipe.

No deduction will be made from the measured lengths of vitrified clay pipe sewer because of Y-branches or Tees.

## Section 306

### Vitrified Clay Pipe Culvert

306.01 GENERAL.—The Contractor shall construct vitrified clay pipe culvert (including encasement in reinforced concrete, plain concrete base, or reinforced concrete foundation, as applicable) including all excavating, lagging, backfilling, restoring pavement, and other Incidental Work, necessary or required, for a complete, satisfactory installation, where and as shown on the plans, or where directed.

306.02 PIPE.—Vitrified clay pipe for culvert shall be the same as specified for main sewers in Section 305.02, except that the culvert and related fittings may be of the spigot type using composition couplings and stainless steel bands to make the joints.

306.03 JOINTS.—Joints for vitrified clay pipe culverts shall be the same as specified for main sewers in Section 305.03, except that composition couplings with stainless steel bands may be used for the applicable joints. Composition couplings with stainless steel bands shall be "Band Seal" as manufactured by the Mission Clay Products Corporation, or an approved equal.

306.04 HANDLING AND STORING.—Pipe shall be handled and stored so as to prevent damage thereto, or to existing improvements. Pipe, when stored, shall be properly blocked to prevent rolling.

306.05 CONSTRUCTION.—Vitrified clay pipe culvert shall be constructed in accordance with the requirements for main sewers as specified in Section 305.05. Culverts shall be laid on a grade of not less than 2 percent (approximately  $\frac{1}{4}$ -inch per foot.)

306.06 PAYMENT.—Vitrified clay pipe culvert (including encasement in reinforced concrete, plain concrete base, or reinforced concrete foundation, as applicable) satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the culvert, between the outside surfaces of sewerage and drainage structures, or to the limits as constructed if the culvert does not terminate in sewerage or drainage structures.

## Section 307

### Vitrified Clay Pipe Side Sewer

307.01 GENERAL.--The Contractor shall construct vitrified clay pipe side sewer including all excavating, lagging, backfilling, restoring pavement and other Incidental Work necessary, or required, for a complete, satisfactory installation, where and as shown on the plans, or where directed.

307.02 PIPE.--Vitrified clay pipe for side sewers shall be the same as specified for main sewers in Section 305.02, except that the side sewers and related fittings may be of the spigot type using composition couplings and stainless steel bands to make the joints.

307.03 JOINTS.--Joints for vitrified clay pipe side sewers shall be the same as specified for main sewers in Section 305.03, except that composition couplings with steel bands may be used for the applicable joints. Composition couplings with stainless shall be "Band Seal" as manufactured by the Mission Clay Products Corporation, or an approved equal.

307.04 HANDLING AND STORING.--Pipe shall be handled and stored so as to prevent damage thereto, or to existing improvements. Pipe, when stored, shall be properly blocked to prevent rolling.

307.05 CONSTRUCTION.--Vitrified clay pipe side sewers shall be constructed in accordance with the requirements for main sewers as specified in Section 305.05. Side sewers shall be connected to the main sewer by means of VCP Y-Branches, Tees, or stubs, as applicable.

When a side sewer is connected to existing vitrified clay pipe main sewers a Y-Branch or Tee of the proper size shall be inserted in the main pipe sewer and the side sewer connected thereto. The cutting or breaking into of a vitrified clay pipe main sewer to connect a new side sewer will not be permitted.

When side sewers are connected to concrete sewers a stub of the proper size shall be installed in the main sewer and the side sewer connected thereto.

Where the diameter of the existing side sewer differs from that of a specified Y-Branch, Tee or stub, the connection shall be made with an appropriate size reducer or increaser, as applicable.

Horizontal and vertical bends in side sewer runs shall not exceed 45 degrees (1/8 bend).

Side sewers shall be laid on a straight grade which grade shall in no case be less than 2 percent (approximately  $\frac{1}{4}$ -inch per foot).

The upper end of each side sewer shall be at a depth sufficient to provide adequate sewerage for the property served. In no case shall the depth of the invert of a side sewer at the curb line be less than 4 feet below curb grade.

In connecting new side sewer to existing side sewer the new side sewer shall be laid on a straight grade from the main sewer to the point of junction. The grade will be such that the deflection angle between the new and existing side sewers, at the junction, shall not exceed 45 degrees so that the connection can be made with a 45-degree or flatter, bend.

The ends of side sewers not in service before the side sewer trenches are backfilled shall be closed with a VCP stopper and marked by the letter "S" placed on the top of the curb directly over the side sewer. The end of each such side sewer shall also be marked by a 2-inch x 2-inch redwood stake running vertically from the bottom of the trench to a point 6 inches below the surface of walk or ground. In new concrete curbs the "S" shall be stamped in the fresh concrete. In the tops of other curbs it shall be neatly cut.

Before marking the "S" on the curb the Contractor shall verify the location of the side sewer by excavating to the top of the redwood stake. If for any reason the stake is not found, the Contractor shall excavate and expose the pipe. In no case shall probing with a bar, or other method, be permitted as a substitute for actual exposure of the stake or pipe.

307.06 PAYMENT. — Vitrified clay pipe side sewer satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the side sewer.

New side sewers (i.e. side sewer constructed for the first time and not a replacement or reconnection of an existing side sewer) shall be measured for payment from the trap connection in the sidewalk area, if connected with a trap, or from the end of the side sewer as constructed, to the centerline of the connecting vitrified clay pipe main sewer or outside surface of concrete sewer or sewerage structure, as applicable.

Existing side sewer reconnection (i.e. replacement of side sewer removed by the operations of the Contractor) within the trench and to the limits of 12 inches outside the lagging, or outside the limits of excavation if not lagged, shall be done as Incidental Work. Existing side sewer reconnection outside of such limits will be paid for under the side sewer Bid Item, or paid for as extra work in accordance with Section 111 if there is no side sewer Bid Item.

## Section 308

### Precast Reinforced Concrete Pipe Sewer

**308.01 GENERAL.** --The Contractor shall construct precast reinforced concrete pipe sewer including all excavating, lagging, back-filling, restoring pavement, and other Incidental Work, necessary or required, for a complete, satisfactory installation, where and as shown on the plans, or where directed.

Precast reinforced concrete pipe shall be manufactured by the Centrifugally Spun or Vertically Cast method with bell and spigot or double spigot with fiberglass collar joints in accordance with the plans and the ASTM "Standard Specifications for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe," Designation C 76, except as modified by the plans, the Special Provisions, and these specifications.

Precast pipe shall have cylindrical interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness. The interior and exterior surfaces shall be concentric at transverse cross sections.

Precast reinforced concrete pipe shall be furnished from a manufacturer who must have had at least five (5) years experience in manufacturing such pipe. The Contractor shall, if requested by the Engineer, submit a list of representative pipe installations for which the manufacturer has furnished pipe during the last five (5) years.

Each section of pipe shall be plainly painted on the inside surface, at the spigot end, with letters and numerals not less than  $1\frac{1}{2}$  inches in height designating the following:

Date of manufacture;

Method of manufacture;

"D-Load" rating;

Top Center (when elliptical reinforcement is used).

To facilitate inspection and testing, each day's run of pipe shall be marked and stored so that pipe manufactured on any particular day may be easily identified.

The strength requirements of the pipe shall be designated in terms of "D-Load." "D-Load" is defined as the load, in pounds per square foot of projected internal diameter, that the pipe will withstand under the standard ASTM 3-edge bearing test before any crack having a width of 0.01 inch or more, and a length of 12 inches or more, occurs.

The required pipe "D-Load" shall be as shown on the plans.

**308.02 CONCRETE.** --Cement and concrete shall be in accordance with Section 900. Cement shall be Type II. Concrete for precast reinforced concrete pipe shall be Class "B", except that the slump shall be adjusted to attain a 28-day strength of at least 5,000 psi. Pipe shall not be transported from the plant until the 5,000 psi strength is developed.

Each section of pipe shall be steam or water cured, or cured using a combination of the two methods, and shall be kept continuously moist for at least 7 days. Curing shall commence within three (3) hours fol-

lowing fabrication. Compression test specimens shall be made, cured in the same manner as the pipe, and tested in accordance with requirements of ASTM "Standard Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, " Designation C 76, except as modified by the testing specifications of Section 308.14.

308.03 CENTRIFUGALLY SPUN.--Pipe manufactured by the centrifugally spinning method shall have smooth interior surfaces free from excessive brush marks or other rough textures. Float rock or other light materials appearing on the inside surface of the pipe will be cause for rejection, unless such imperfections are repaired to the satisfaction of the Engineer.

308.04 VERTICALLY CAST.--Pipe manufactured by the vertical cast method shall have smooth interior surfaces, relatively free from pits and airholes. The concrete shall be placed between rigid internal and external forms extending the full length of the pipe and compacted by high frequency vibration.

The vibrators shall be rigidly attached to the exterior of the form by bolting, clamping, or welding. The vibrators shall be adequate in size and number and of sufficient frequency to properly compact the concrete.

The vibrators shall be operating at all times during the placement of concrete.

308.05 DIMENSIONS AND TOLERANCES.--Pipe shall be furnished in lengths not less than 6 feet; except for the closing sections to structures, where cast or cut lengths not less than 3 feet in length may be used.

Pipe sections 6 feet diameter and larger, in which manhole openings are provided, shall be not less than 7 feet long.

The minimum wall thickness of pipe smaller than 42 inches in diameter shall be in accordance with ASTM "Standard Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe," Designation C76. Pipe 42 inches in diameter and larger shall have a minimum protective covering of concrete over steel reinforcement of  $1\frac{1}{2}$  inches from the outer surface and one inch from the inner surface.

The minimum thicknesses of bells at the base and spigots shall be in accordance with the applicable requirements set forth in the following schedule:

12-inch diameter through 24-inch diameter inclusive:

Pipe bells and spigots each shall be at least  $1\frac{3}{4}$  inches thick.

27-inch diameter through 60-inch diameter inclusive:

Pipe bells and spigots each shall be at least  $2\frac{1}{4}$  inches thick.

63-inch diameter and larger size diameters inclusive:

Pipe bells and spigots each shall be at least 45 percent of the thickness of the respective pipe barrel wall.

In determining minimum thicknesses no reduction will be made from the thickness of spigots because of normal gasket grooves. However, in any case, gasket grooves shall not be made so as to leave less than  $\frac{3}{4}$ -inch of concrete cover on reinforcing steel.

308.06 CONTRACTOR TO FURNISH DETAILS.—The Contractor shall furnish to the Engineer for approval six (6) copies of the complete design details of the precast reinforced concrete pipe, including joints, he intends to furnish.

308.07 HANDLING AND STORING.—Pipe shall be handled and stored so as to prevent damage thereto, or to existing improvements. Pipe, when stored, shall be properly blocked to prevent rolling.

Any pipe which, in the opinion of the Engineer, has been damaged to the extent of being beyond repair, will be marked "rejected" and shall be immediately and permanently removed from the site of the work by the Contractor.

Cross-bracing is required for all precast pipes 6'-0" diameter and larger. The cross-bracing shall be placed inside the pipe such that no deformation will occur. The cross-bracing shall be installed prior to any transportation or handling of the finished pipe. The cross-bracing shall not be removed until the trench has been fully backfilled and compacted. In no case shall there be less than two sets of cross-bracing installed per pipe length.

308.08 CUTTING PIPE.—Cut lengths of pipe shall be neatly cut to a smooth transverse edge with a masonry saw or other approved means in such manner as to not spall the concrete from the surfaces of the pipe or unnecessarily expose the reinforcing steel.

Any pipe damaged by cutting to an extent that it is unsatisfactory for use in the sewer shall be replaced with a new and undamaged length of pipe by the Contractor at his expense, or if allowed by the Engineer, shall be repaired in an approved manner. Spalled areas to be repaired shall be satisfactorily filled with Class "A" mortar and reinforcing steel shall be cut back where necessary and the holes filled, also with Class "A" mortar, so that the mortar covering the steel is not less than  $2\frac{1}{2}$  inches thick, measured from the cut face of the pipe.

Hand cutting of pipe will be permitted if holes outlining the line of the cut are cleanly drilled and the intervening concrete satisfactorily cut out with approved hand tools. Light pneumatic chipping hammers that, in the opinion of the Engineer, will cut satisfactorily without shattering the adjacent concrete, may be used. The use of sledge hammers or pneumatic jack hammers will not be permitted.

308.09 JOINTS: GENERAL.—Pipe joints shall be bell and spigot, or double spigot with fiber glass collar. Spigot ends shall be reinforced concrete with an annular groove formed into the outer surface containing a continuous round neoprene gasket compressed therein by the inner surface of a reinforced concrete bell or fiber glass collar. The joint shall be self-centering and designed so as to prevent the neoprene gasket from supporting the weight of the pipe.

Each joint shall be watertight, without imperfections, and approved by the Engineer before another section of pipe is installed. The location of the neoprene gasket within the completed joint will be determined by the use of a feeler gauge.

While joining sections of pipe, the Contractor shall use a "come-along" to seat the pipe section being installed.

The joint gap on the inside of the sewer between sections of pipe shall not exceed  $3/4$  inch. If the joint gap is  $3/8$  inch or more the Contractor shall fill such gap with an approved epoxy mortar, mixed to stiff consistency, and finished flush with the pipe walls.

Joints connecting pipes to structures shall be integrally cast with the structure or made with Class "A" cement mortar. Imperfections of cast joints shall be repaired with Class "A" cement mortar.

Cement mortar shall be in accordance with the requirements of Section 900.09.

Any pipe section that cannot be laid to give a proper joint with the approved overlap shall be replaced with a suitable pipe section or the joint shall be reinforced with an approved concrete collar not less than 6 inches thick and 12 inches long, containing not less than 3-circumferential No. 4 steel reinforcing bars with suitable spacers. The outside surface of the pipe at the joint shall be roughened to provide satisfactory bond with the collar.

A cut end of pipe may only be used for the closing connection with concrete structures and manhole bases. The cut end shall extend into the wall of the structure or manhole base. The wall of the structure or manhole shall be placed around the end of the cut length of pipe.

308.10 BELL AND SPIGOT ENDS OF PIPE. --The outside surfaces of the spigots, and the inside surfaces of the bells, shall be accurately formed to provide readily made close fitting joints, the average clearance of which shall not exceed 0.08 inch.

The taper on the conic surface of the inside of the bell and the outer surface of the spigot shall not be more than 3 degrees measured from a longitudinal trace on the inside surface of the pipe.

The joint lap distance at each spigot shall be at least  $3-3/8$  inches.

The bell reinforcement and the spigot reinforcement shall each be at least equal in quantity and quality to the steel in the pipe barrel wall with extra steel being added, as necessary, to reinforce ends of pipe against normal construction and shipping stresses.

308.11 BEVEL JOINTS. --Bevel joints, when specified in the Special Provisions, shall be of the bell and spigot type as set forth in Section 308.09 and the horizontal deflection thereof shall not exceed 5 degrees. The longitudinal centerline of pipe at each bevel joint shall be located on the indicated centerline of the sewer. Horizontal deflection will be permitted only at bevel joints or within structures.

308.12 DOUBLE SPIGOT WITH FIBER GLASS COLLAR JOINTS. --Each joint shall consist of two continuous ring neoprene gaskets, each mounted in an annular groove formed into the outer surfaces of the spigots of adjoining precast reinforced concrete double spigot pipe and suitably contained and compressed under a fiber glass reinforced collar.

Collars for the 63-inch diameter pipe and larger shall be reinforced with 4 outer layers of fiber glass cloth, 8 intermediate layers of fiber

glass filaments, and 4 inner layers of fiber glass cloth, all of which shall be bonded in epoxy resin. Each collar shall be at least 7 inches wide and at least 0.450 inches thick exclusive of edge taper.

Collars for the 27-inch diameter to 60-inch diameter pipe shall be reinforced with 3 outer layers of fiber glass cloth, 6 intermediate layers of fiber glass filaments, and 3 inner layers of fiber glass cloth, all of which shall be bonded in epoxy resin. Each collar shall be at least 7 inches wide and at least 0.256 inches thick exclusive of edge taper.

Collars for the 12-inch diameter to 24-inch diameter pipe shall be reinforced with 2 outer layers of fiber glass cloth, 4 intermediate layers of fiber glass filaments, and 2 inner layers of fiber glass cloth, all of which shall be bonded in epoxy resin. Each collar shall be at least 7 inches wide and at least 0.256 inches thick exclusive of edge taper.

Immediately prior to joining pipes, each collar will be inspected by the Engineer in the field and any collars with cracks, white crazemarkers or any other defect which would result in potential leaks or structural failure shall be replaced with a new collar, all at the Contractor's expense.

The outside surfaces of the spigots, and the inside surfaces of the collars, shall be accurately formed to provide readily made close fitting joints, the average clearance of which shall not exceed 1/16-inch. The joint lap distance at each spigot shall be approximately  $3\frac{1}{2}$  inches.

**308.13 NEOPRENE GASKETS.**—Each gasket shall be a continuous ring of such size and cross section as to completely fill the groove in the spigot when the pipe joint is assembled. The gasket shall make the joint watertight under normal conditions of service including expansion, contraction, and normal earth settlement.

The gaskets shall be manufactured from a synthetic rubber compound in which the elastomer is neoprene exclusively, and shall not contain reclaimed rubber or any deleterious substance. All gaskets shall be extruded or molded and cured in such a manner that any cross section will be dense, homogeneous, and free from porosity, blisters, pitting and other imperfections. The tolerance for any diameter shall be plus or minus 1/64-inch.

The neoprene gasket length shall not be stretched more than 20 percent when placed on the spigot.

The joint design and tolerances shall be such that when the outer surface of the spigot comes into contact with the inner surface of the bell or collar that the deformation in the neoprene gasket shall not exceed 50 percent and at a point diametrically opposite the gasket the minimum deformation shall not be less than 15 percent.

The compound shall meet the following physical requirements:

- a) Neoprene (by volume), minimum percent..... 50
- b) Tensile strength, psi, minimum, ASTM D 412 ..... 2100
- c) Elongation at rupture, minimum percent, ASTM D 412 .... 425

- d) Shore Durometer, ASTM D 676, Type "A" ..... 35 to 60  
(The test shall be performed on the flat cross section of a  $\frac{1}{4}$ -inch length of gasket.)
- e) Compression Set (of original deflection), maximum percent, ASTM D 395, Test Method "B" .....20  
( $\frac{1}{2}$ -inch long section of gasket, constant deflection, 22 hours at 158° F)
- f) Accelerated aging in air (70 hours at 212° F), ASTM D 753  
Tensile strength (of original strength), minimum percent...85  
Hardness change, maximum percent .....+15

Written certification that the gaskets comply with the specifications set forth immediately hereinbefore shall be furnished to the Engineer prior to installation. Each gasket, the groove containing it, and the inside surface of the bell or collar compressing it, shall be coated with an approved manufacturer's recommended lubricant immediately prior to installation.

**308.14 TESTING.**-- The Contractor shall make available testing equipment and samples, and shall test or have tested precast reinforced concrete pipe by standard 3-edge bearing and compression tests in accordance with ASTM "Standard Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe", Designation C 76, except as modified by the plans and these specifications.

The Contractor shall furnish the Engineer with Compression Test results for each manufacturer's run, size, and "D-Load" of pipe specified.

At the option of the Engineer, the Contractor shall furnish complete test data of the pipe he intends to furnish, two standard concrete cylinders, and two core samples from each run, size, and "D-Load" of the specified pipe for testing by the City.

The Engineer may select from each size, "D-Load", or 400-linear feet of pipe one length for 3-edge bearing testing, and at the Engineer's request all tests shall be performed in his presence. The minimum length for 3-edge bearing testing shall be 6-linear feet. For each pipe that fails to meet the "D-Load" requirements two additional lengths of the same run, size, and "D-Load" shall be tested. If these pipes meet the "D-Load" requirements the shipment will be accepted. If these pipes do not meet the "D-Load" requirement, testing shall be continued as determined by the Engineer until he approves or rejects the shipment.

For precast pipe sizes larger than 108-inch diameter the 3-edge bearing test will not be required. In lieu thereof, the Contractor shall submit to the Engineer notarized certificates obtained from the pipe manufacturer to verify:

- 1) The 28-day strength of the concrete, as determined from crushing tests in accordance with ASTM Designation C 76 on (a) stand-

ard concrete cylinders, or (b) core samples; the latter being in addition to the former and at the option of the Engineer;

- 2) The density of the concrete as in the finished pipe product;
- 3) The strength and type of steel used;
- 4) That production of the pipe is in compliance with ASTM Designation C 76, except as modified by the plans and these specifications.

In addition to the samples, tests, and test results required hereinbefore, the City reserves the right to require additional samples, tests, and test results to properly examine the precast reinforced concrete pipe as determined necessary by the Engineer.

**308.15 PAYMENT.**—Precast reinforced concrete pipe sewer satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of sewer, exclusive of manholes and structures, between the outside surfaces of manholes and structures, or to the limits as constructed if the sewer does not terminate in manholes or structures.

Precast reinforced concrete pipe sewer connecting to a manhole or structure by a collar or boss shall be measured to the outside surface of such collar or boss at the point of connection with the pipe.

No deduction will be made from the measured length of precast reinforced concrete pipe sewer because of collars constructed thereon to reinforce the joint between sections of precast pipe. The collars constructed to reinforce the joint shall be done as Incidental Work.

No deduction will be made from the measured length of precast reinforced concrete pipe sewer because of manhole cones constructed thereon.

## Section 309

### Cast-in-Place Reinforced Concrete Sewers and Sewer Structures

**309.01 GENERAL.**—The Contractor shall construct cast-in-place reinforced sewers and sewer structures including all excavating, lagging, forming, backfilling, restoring pavement and other Incidental Work, necessary or required, for a complete, satisfactory installation, where and as shown on the plans, or where directed. Such sewers and sewer structures shall be of Class "B" concrete constructed in accordance with the plans, the applicable requirements of Sections 421 and 900, and these specifications. Cement shall be Type II.

All appurtenances for structures, such as frames, covers, gratings, wrought iron steps, VCP stub inlets, and VCP stub inverts shall be furnished and installed where and as shown on the plans and as specified.

309.02 FORMWORK.--Lagging shall not be used as a surface against which concrete is placed unless permitted in the Special Provisions. Sufficient clearance shall be maintained between the formwork and lagging so that the alignment and cross section of the work as shown on the plans can be obtained by adjustment of such formwork.

No concrete shall be placed in formwork unless such formwork is constructed to the required alignment, grade, and cross sections, and is approved by the Engineer. Such approval shall in no way relieve the Contractor of the responsibility for obtaining, in the completed work, the alignment, grade and cross sections shown on the plans.

The use of twisted wire loops as form ties will not be permitted.

Smooth forms accurately held on line and grade shall be used. Forms and centers may be made of either metal or timber. The surfaces of all timber forms that come in contact with the inside surfaces of concrete sewers and sewer structures shall be laid with close joints and oiled with a non-staining mineral oil.

Sharp corners shall be chamfered one inch, and 3/4-inch x 3/4-inch triangular fillets shall be used in all angles of formwork unless otherwise shown on the plans or directed by the Engineer.

309.03 INVERT FORMS.--Inverts of sewers and sewerage structures shall be formed by the use of fixed and rigid forms when the invert radius is 2'-0" or less. Inverts with a radius larger than 2'-0" and smaller than 2'-6" shall also be formed by the use of fixed and rigid forms unless the Engineer approves otherwise. Such approval will depend on the concrete's slump and its ability to satisfactorily form the invert shape by screeding. When fixed and rigid formwork is required, shaping the inverts with screeds or other means will not be allowed.

309.04 CONSTRUCTION.--The invert of the sewer or structure, up to the key joint, shall be constructed first. The concrete shall be carefully and properly placed and vibrated. No traffic of any kind will be permitted on the invert for at least twenty-four (24) hours after placing. Concrete for the sides and tops of sewers and sewer structures not on piles shall not be placed until at least forty-eight (48) hours have elapsed after the placement of invert concrete; and in the case of sewers and sewer structures on piles not until at least seventy-two (72) hours have elapsed after the placement of invert concrete.

No more wall and top section shall be started than can be completed the same day.

Vertical construction joints with proper keyways shall be made at the end of each pour. Construction joints in invert and walls shall not be in the same plane, but shall be staggered.

Immediately after the removal of the forms and centers, all rubbish and surplus materials shall be removed from the sewer or structure in order to prevent any possibility of their entering the City's sewer system.

309.05 FORM REMOVAL.--The period of time and the strength of concrete required before the removal of forms shall be in accordance

with Section 421.09 except that formwork for arch type concrete sewers and sewer structures need only remain in place for a minimum period of seventy-two (72) hours after the placement of concrete therein. If forms are removed before a period of seven (7) days, extra care shall be taken in the removal of forms in order not to spall the "green" concrete.

Invert forms shall be removed at the proper time to allow thorough steel troweling.

**309.06 FINISHING.**—Concrete surfaces of sewers and sewer structures shall be given an "Ordinary Surface Finish" in accordance with the requirement of Section 421.10, except that such surfaces, or portion thereof, covered by backfill in the completed work need not be sacked.

Inverts of sewers and sewer structures shall be steel troweled to a smooth uniform surface.

**309.07 CURING.**—Cast-in-place reinforced concrete sewers and sewer structures shall be cured by water or impervious membrane curing in accordance with these specifications.

No traffic of any kind will be allowed over the sewer during the curing period.

Immediately after the sewer invert has been poured, it shall be covered with wet burlap and kept wet for a period of seven (7) days. The Contractor may, after twenty-four (24) hours, replace the burlap with straw, sawdust, or earth kept thoroughly wet until the expiration of the 7-day period.

The concrete in the top and sides of the sewer or structure shall be cured by being kept continuously moist, either by sprinkling, wet burlap, or wet earth, for a period of seven (7) days.

Concrete curing by means of an impervious membrane shall be done using an approved liquid which will form an impervious, non-slippery membrane when dry. The liquid shall have a temporary color sufficient to indicate the extent of its application. The membrane shall form a hard film and thoroughly waterproof the concrete surface within thirty (30) minutes.

No membrane will be allowed on steel reinforcement. The Contractor shall protect exposed steel reinforcement during membrane application. Any and all membrane on steel reinforcement shall be removed before additional placement of concrete will be allowed.

Membrane curing liquids shall be applied under pressure with a spray nozzle at such a rate as to seal the surface uniformly and completely. The membrane seal shall be protected from injury for ten (10) days and any breaks in the membrane during this period shall be repaired immediately by a fresh application of the liquid.

**309.08 FRAMES, COVERS, AND GRATINGS.**—Cast iron frames, covers, and gratings shall be furnished and installed on sewer structures where and as shown on the plans, or where directed, and in accordance with the requirements of Section 901.01.

Each casting shall have its weight indicated thereon with white paint.

Care shall be exercised to cast the contact surfaces in a true plane and free from irregularities. These surfaces shall be machined or ground to insure uniform contact between frame and cover or grating.

309.09 WROUGHT IRON STEPS.--All steps for sewer structures shall be fabricated from genuine wrought iron, hot-dip galvanized after fabrication, and in accordance with the details shown on the plans. The Contractor shall certify in writing that the steps installed are of wrought iron and in accordance with the requirements of ASTM "Standard Specifications for Rolled Wrought Iron Shapes and Bars", Designation A 207.

309.10 PAYMENT.--Cast-in-place reinforced concrete sewer satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of sewer between the outside surfaces of structures, or to the limits as constructed, as applicable.

No deduction will be made from the length of cast-in-place reinforced concrete sewers because of manholes constructed thereon.

Cast-in-place reinforced concrete sewer structures satisfactorily constructed complete, in place, will be paid for at the respective lump sum price bid therefor. Appurtenances, such as frames, covers, gratings, wrought iron steps, stub inlets, and VCP inverts shall be considered as part of the structure and no direct or additional payment will be made therefor.

## Section 310

### Manholes

310.01 GENERAL.--The Contractor shall construct manholes complete with frames, covers, gratings, wrought iron steps, VCP stub inlets, and including excavating, lagging, backfilling, restoring pavement and other Incidental Work, necessary or required, for a satisfactory installation, where and as shown on the plans, or where directed.

Manholes shall be constructed to conform to the improved street surface. In unimproved areas if the ground surface is below the official grade, the manhole shall be constructed to conform to such official grade unless otherwise indicated on the plans; and if the ground surface is above the official grade, the manhole shall be so constructed that the internal diameter, at the proper elevation to conform to the official grade, is  $24\frac{1}{2}$  inches, and shall be continued upward, with the same diameter, to conform to the ground surface.

Manholes shall be constructed of Class "B" concrete precast sections in accordance with the applicable requirements of Section 308 or cast-in-place in accordance with the applicable requirements of Section 309. Precast concrete manholes shall be supported on a cast-in-place concrete base.

**310.02 SPECIAL MANHOLES.**--Drop manholes and other special manholes shall be constructed as shown on the plans and in accordance with the requirements set forth herein. Drop manholes shall include the drop connection and drop pipe as part of its structure.

**310.03 MANHOLE FRAMES, COVERS, GRATINGS, AND STEPS.**--Cast iron manhole frames, covers, gratings, and wrought iron steps shall be furnished and installed as shown on the plans and as specified in Sections 309.08 and 309.09.

**310.04 PAYMENT.**--Manholes satisfactorily constructed complete, in place, as specified, will be paid for at the unit price bid therefor. The unit price bid for a manhole on a reinforced concrete sewer shall include all expense, due to such manhole, over and above the cost of the sewer without such manhole.

## Section 311

### Catchbasins

**311.01 GENERAL.**--The Contractor shall construct catchbasins complete with curb inlets, frames, gratings, traps, and including excavating, lagging, backfilling, restoring pavement, and other Incidental Work, necessary or required, for a satisfactory installation where and as shown on the plans, or where directed.

Catchbasins shall be constructed of Class "B" concrete precast sections in accordance with the applicable requirements of Section 308 or cast-in-place in accordance with the applicable requirements of Section 309. Precast catchbasins shall be supported on a cast-in-place concrete base.

Unless otherwise shown on the plans, catchbasin gratings shall be 9 inches below curb grade.

**311.02 CURB INLETS.**--Curb inlets shall be constructed as shown on the plans and shall comply with the requirements for concrete curbs.

When two inlets are specified for catchbasins with multiple curb inlets, the center inlet shown on the Standard Plan shall be eliminated.

The curb inlets, or slabs, as the case may be, shall conform to the adjacent curb and sidewalk.

**311.03 CATCHBASIN FRAMES, GRATINGS, AND TRAPS.**--Cast iron catchbasin frames, gratings, and traps shall be furnished and installed as shown on the plans and as specified in Section 309.08. Unless otherwise specified gratings shall be 9 inches below the curb.

Each casting shall have its weight indicated thereon with white paint.

Care shall be exercised to cast the contact surfaces in a true plane and free from irregularities. These surfaces shall be machined or ground to insure uniform contact between the grating and frame.

311.04 PAYMENT.—Catchbasins satisfactorily constructed complete, in place, as specified, will be paid for at the unit price bid therefor.

## Section 312

### Storm Water Inlets

312.01 GENERAL.—The Contractor shall construct storm water inlets complete with curb inlets, frames, gratings, and including excavating, lagging, forming, backfilling, restoring pavement, and other Incidental Work necessary, or required, for a satisfactory installation, where and as shown on the plans, or where directed.

Storm water inlets shall be constructed of brick or concrete.

312.02 BRICK STORM WATER INLETS.—Brick storm water inlets shall be constructed of common bricks and Class "B" mortar in accordance with Sections 320 and 900.09. The entire inner surface of the brickwork shall be plastered with a smooth coat of Class "A" mortar which shall be at least 1-inch thick on the invert and 3/8-inch on the walls. In soft ground, the foundation slab shall be constructed of Class "B" concrete.

312.03 CONCRETE STORM WATER INLETS.—Concrete storm water inlets shall be constructed of cast-in-place Class "B" concrete in accordance with Sections 421 and 900. Construction shall be in accordance with the applicable requirements of Section 309.

312.04 CURB INLETS.—Curb inlets shall be constructed where and as shown on the plans and in accordance with the requirements of Section 311.02.

312.05 STORM WATER INLET FRAMES AND GRATINGS.—Storm water inlet frames and gratings shall be furnished and installed where and as shown on the plans and in accordance with Sections 311.03 and 901.01.

312.06 PAYMENT.—Storm water inlets satisfactorily constructed complete, in place, as specified, will be paid for at the unit price bid therefor.

## Section 313

### Vitrified Clay Pipe Subdrain

**313.01 GENERAL.**—The Contractor shall furnish and install subdrains complete with Tees, risers, burlap, oakum, mortar, concrete, crushed rock, including the subsequent removal or plugging of such facilities, as applicable, and other Incidental Work, necessary or required, all as specified herein.

When a Bid Item or Items for subdrains of a specified size or sizes are included in the Proposal, the Engineer will, under such Bid Items, order sufficient subdrains, in his opinion, to maintain an appropriately dry excavation, free from ground water, and to temporarily carry the flow of cut side sewers, if any. Main sewer flow and storm water flow shall be diverted as required in Section 302, except that excess capacity of ordered subdrains may be used to temporarily carry main sewer flow.

Additional or larger subdrains may be used by the Contractor if he so desires but no payment will be made on account of such increase in extent or size of subdrains.

**313.02 PIPE.**—Subdrain pipe and fittings shall be in accordance with the requirements of Section 305.02, except that such pipe and fittings may be sound second quality.

**313.03 CONSTRUCTION.**—Subdrains for pipe sewers shall be located at one side of the sewer trench, and subdrains for encased pipe sewers and pipe sewers on concrete foundations shall be located either at one side of the sewer trench or beneath such main pipe sewer. Subdrains for cast-in-place concrete sewers shall underlie or be below and adjacent to the sewer and be connected to the invert by Tees and risers placed in a manner which will allow plugging the subdrain upon completion of the sewer.

Upon conclusion of the need therefor, subdrains for pipe sewers, unless specifically required to remain as permanent subdrains, shall be removed or plugged with concrete at intervals not greater than 100 feet.

Subdrains underlying a cast-in-place concrete sewer shall be temporarily connected to the sewer invert by vitrified clay pipe Tees and risers of the same diameter as the subdrain at intervals not greater than 100 feet. Before the sewer is put into service the subdrains at the risers, and the risers, shall be permanently plugged with concrete.

Subdrain pipe laid in soil other than sand shall be covered with crushed rock extending at least 6 inches laterally from each side of the pipe and 12 inches vertically above the top of the pipe. Where subdrains pass through areas free of ground water, the joints shall be filled with lean mortar and crushed rock may be omitted. Crushed rock shall be uniformly graded from No. 4 to 3/4-inch sieve size.

When required in the Special Provisions, the aforementioned crushed

rock shall be completely dammed with a concrete cutoff wall at specified intervals so as to prevent any possibility of continuity of ground water flow along the line of the sewer or structure. Cutoff walls shall be not less than one foot thick, shall block the entire width of the rock fill, and shall extend not less than one foot into the ground below the crushed rock. Concrete used for this purpose shall be Class "D" or better. Where Tees and risers have been installed, the cutoff walls shall be located at the Tees and risers. If the crushed rock is specifically required to remain in use in conjunction with a permanent subdrain no cutoff walls will be required.

Open subdrain joints shall be wrapped with burlap and, in addition, when the pipe is laid in sand, shall be loosely packed with oakum.

313.04 SIDE SEWERS. --Side sewers cut along the line of the work shall be temporarily connected to the subdrain by means of pipes and fittings. When side sewers are permanently reconnected, temporary connections shall be removed from the site by the Contractor as his property and the subdrains shall be plugged with concrete or brickwork at the temporary connection openings.

313.05 PAYMENT. --Vitrified clay pipe subdrain satisfactorily constructed, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of the subdrain within the limits ordered by the Engineer.

No deduction will be made in the measured length because of fittings.

## **Section 314**

### **Crushed Rock Layer**

314.01 GENERAL. --The Contractor shall furnish and install an 8-inch minimum thickness crushed rock layer including all necessary or required Incidental Work.

When a Bid Item for crushed rock is included in the Proposal, the Engineer will, under such Bid Item, order crushed rock where necessary, in his opinion, to maintain an appropriately dry subgrade. Sanitary and storm water flow shall be handled and disposed of in accordance with the requirements of Section 302.

Crushed rock shall be uniformly graded from No. 4 to 3/4-inch sieve size.

The crushed rock layer shall be placed within the longitudinal limits and widths ordered by the Engineer. Such ordered widths will not exceed the outside width of the sewer, structure, or manhole base, as the case may be, plus two feet. Crushed rock placed in excess of the required minimum thickness, or outside the limits ordered by the Engineer, shall be at the Contractor's sole expense, and no direct or additional payment will be made therefor.

314.02 PAYMENT.—Crushed rock layer satisfactorily furnished and installed, in place, as specified, will be paid for at the price bid per square foot, measured horizontally within the limits ordered by the Engineer.

When subdrains are used in conjunction with a crushed rock layer, no reduction in the quantity of crushed rock will be made because of the construction of subdrains and related appurtenances within the layer.

## Section 315

### Connections to Existing Structures, Sewers, Side Sewers, and Culverts

315.01 GENERAL.—The Contractor shall make all connections to existing sewerage and drainage structures, sewers, side sewers, and culverts where shown on the plans, or necessary, in order that the completed work will function as an integral part of the sewerage system. Connections shall be constructed in a manner to produce smooth junctions.

315.02 ELEVATIONS AND LOCATIONS.—Elevations and locations of existing sewers, structures, and other facilities shown on the plans are approximate only. Exact elevations of connections must be determined in the field before commencing excavation operations. If no manhole opening or other access is readily available for determining the elevation or location of the connection point, the Contractor shall expose the existing sewer or structure, as necessary to make such determinations.

315.03 PIPE CONNECTIONS TO EXISTING BRICK OR CONCRETE SEWERS OR STRUCTURES.—Unless otherwise specified, where pipe sewer or culvert is to be connected to a brick or concrete sewer or structure, the opening therefor shall be kept to a practicable minimum and the joint shall be made with Class "A" cement mortar.

315.04 PAYMENT.—Connections to existing structures, sewers, side sewers, and culverts shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 316

### Vitrified Clay Pipe Y-Branch

316.01 GENERAL. --The Contractor shall furnish and install vitrified clay pipe Y-branches where and as shown on the plans, or where directed, including all necessary, or required, Incidental Work.

316.02 Y-BRANCH. --Y-branches shall be made of vitrified clay in accordance with the applicable requirements of Section 305.02.

316.03 INSTALLATION. --Y-branches shall be installed in accordance with the applicable requirements of Section 305.05.

Branch inlets shall be not less than 6 inches in diameter in residential districts, and not less than 8 inches in diameter in industrial and commercial districts. If any existing side sewer is of a larger diameter, the branch inlet shall be of such diameter.

316.04 Y-BRANCHES TO BE CLOSED AND MARKED. --The bells of all Y-branches not in service before the excavation is backfilled shall be closed with vitrified clay stoppers. The bell shall be covered with cheese cloth, so as to separate the bell from the mortar and stopper, after which the stopper shall be inserted and made watertight with Class "A" cement mortar on the outside only. When the branches are to be left exposed the stoppers shall also be securely fastened in place with galvanized wire.

Each Y-branch to which no connection is made, shall be marked by a 2-inch x 2-inch redwood stake running vertically from the bottom of the trench at the branch to a point one foot below the surface of the street. Care shall be taken to maintain the stake in its correct position during backfilling. In addition to the redwood stake, the letter "Y" shall be stamped or neatly chipped in the top of the curb opposite each "Y" branch from which a side sewer has not been constructed.

316.05 PAYMENT. --Y-branches satisfactorily constructed complete, in place, as specified, will be paid for at the unit price bid therefor.

## Section 317

### Stub Inlets

**317.01 GENERAL.** --The Contractor shall furnish and install vitrified clay pipe stub inlets in concrete sewers, manholes, and structures where and as shown on the plans, or where directed, including all necessary or required Incidental Work.

**317.02 STUB INLET.** --Stub inlets shall be made of vitrified clay in accordance with the applicable requirements of Section 305.02.

Stub inlets for side sewers shall be of the diameters specified for Y-branch inlets in Section 316.03. Stubs for culvert connections to catchbasins shall be 10 inches in diameter, and those for tributary sewers shall be of the diameters of such sewers.

**317.03 JOINTS.** --Each stub installed in a sewer or structure shall be mortared in place with Class "A" cement mortar, or an approved epoxy mortar.

Stub inlets shall be set with the back of the bell placed as close as practicable to the outside surface of the sewer or manhole, and shall be of such length that the inner spigot end shall be flush with the inside surface. They shall be securely fastened in the formwork so that they will not be displaced from their correct positions during placing of the concrete.

**317.04 INSTALLATION IN PRECAST CONCRETE PIPE.** --All holes in precast concrete pipe for stub inlets shall be cut in accordance with the plans and the requirements of Section 308.08. Reinforcing bars within the hole shall be cut so as to clear the stub by not less than one inch.

Where the edge of the hole is less than 18 inches from the end of a pipe, or where the clearance between two holes is less than 18 inches, a ring bar of No. 5 reinforcing steel shall be welded to each cut bar. The hole shall be cut sufficiently large to provide a 1-inch clearance between the ring bar and the stub. Clearance between two cut holes or between a cut hole and the end of the pipe shall not be less than 6 inches.

**317.05 STUB INLETS TO BE CLOSED AND MARKED.** --The bells of all stub inlets not in service before the excavation is backfilled shall be closed with vitrified clay stoppers. The bell shall be covered with cheese cloth, so as to separate the bell from the mortar and stopper, after which the stopper shall be inserted and made watertight with Class "A" cement mortar on the outside only. When the stubs are to be left exposed, the stoppers shall also be securely fastened in place with galvanized wire.

Each stub inlet to which no connection is made, except stub inlets in manholes, shall be marked by a 2-inch x 2-inch redwood stake running vertically from the bottom of the trench at the stub to a point one foot

below the surface of the street. Care shall be taken to maintain the stake in its correct position during backfilling. In addition to the red-wood stake, the letter "Y" shall be stamped or neatly chipped in the top of the curb opposite each stub inlet from which a side sewer has not been constructed.

317.06 PAYMENT. --Stub inlets satisfactorily constructed complete, in precast reinforced concrete sewer pipe, as specified, will be paid for at the unit price bid therefor.

Stub inlets installed in manholes and in cast-in-place sewers and sewer structures shall be done as Incidental Work and payment therefor shall be included in the price or prices bid for the respective manholes and structures.

## **Section 318**

### **Gunite Sewer Lining**

318.01 GENERAL. --The Contractor shall construct gunite lining on the interior surface of the sewer, manholes, and structures including all cleaning, placing, finishing, curing, and other Incidental Work, necessary or required, for a complete, satisfactorily constructed gunite lining, where and as shown on the plans, or where directed.

Gunite lining shall be constructed in accordance with the applicable requirements of Section 423 except as modified by these specifications.

The gunite lining in manholes and structures shall be constructed to one foot above the crown of the highest adjacent main sewer.

The construction of gunite lining shall include completely filling all cavities and removing all protrusions to obtain a uniform gunite surface.

318.02 NIGHT WORK. --The Contractor, if he so elects, may do the contract work until 10:00 p.m. at night in order to work during periods of low sewage flow and to facilitate diversion of sewage. If night work is to be performed the Contractor shall notify the Engineer, in writing, at least twenty-four (24) hours in advance of starting such night work.

318.03 LIGHTING AND VENTILATION. --The Contractor shall furnish illumination and ventilation in the sewer adequate to permit good workmanship and proper inspection. Electric lights and other electrical equipment shall comply with the requirements of the Electrical Safety Orders of the State of California Division of Industrial Safety.

318.04 CLEANING. --The Contractor shall clean the surfaces to be gunited in order to effect a satisfactory bond between the gunite and such surfaces. Initially, the Contractor may use mattocks, light pneumatic tools, or other means approved by the Engineer, to remove de-

posits and scum from the surfaces to be gunited. Subsequently, the Contractor shall use high pressure air and water, sandblasting, a combination thereof, or approved equivalent means, to remove all film, scum and other foreign materials.

Guniting shall be applied only to clean surfaces upon which there is no sewage, scum, oil, or free water, but the surface shall be sufficiently damp to prevent absorption.

318.05 CROWN AND SIDE WALLS. --Type II cement shall be used in the guniting mix for the crown and side walls.

The Contractor may use calcium chloride in conjunction with Type II cement as an admixture to accelerate the setting of the guniting. Calcium chloride shall be in accordance with the requirements of ASTM "Standard Specifications for Calcium Chloride," Designation D 98. Two pounds of calcium chloride shall be used for each sack of cement in the mix, mixed in a manner which will assure an even distribution of the calcium chloride throughout the mixture.

318.06 INVERT. --Cement for guniting for the invert of the sewer, up to a height of at least 12 inches above the invert, shall consist of a combination of Type I Portland cement and calcium-aluminate cement. Calcium-aluminate cement shall be in accordance with the requirements of Section 423.04.

318.07 WORK AT VOIDS AND CAVITIES. --All voids around the exterior surface of existing connecting side sewers and culverts, and all other voids and cavities, shall be completely filled with guniting.

Each side sewer shall be temporarily plugged while the sewer wall is being gunited in the area immediately surrounding such side sewer. Upon completion of guniting at each such area, the temporary plug shall be removed.

Infiltration leaks which may occur shall be suitably caulked and sealed with oakum or other approved materials and then gunited.

The thickness of the guniting lining shall be increased as necessary at depressions, hollows, and cavities, so that the finished surface will conform to the designed shape of the sewer and will have a uniform slope.

318.08 REBOUND. --Material which rebounds and does not fall clear of the work, or which collects in the invert, shall be blown off and removed from the work in a suitable manner and shall not be reused. No portion thereof shall be dumped upon paved streets, into catchbasins, or otherwise into the City sewer system.

318.09 FINISH. --All guniting surfaces shall be given a screeded and flash coated finish, with high spots removed and low spots filled, then steel troweled to obtain a smooth surface with a minimum trowel pressure. Troweling shall be done not more than one hour after placing the guniting.

318.10 CURING.--All sewage shall be suitably diverted from the newly gunited surfaces during the 6-hour period immediately following the completion of the guniting of such surfaces, except that in the case of the sewer invert, a 2-hour period will be sufficient.

318.11 PAYMENT.--Gunite sewer lining satisfactorily constructed, complete, in place, as specified, will be paid for at the price bid per square foot, computed as the product of the mean circumference of the lining and the length of sewer gunited measured horizontally along the centerline of the sewer, with no deduction from the total length because of the existence of manholes, structures, side sewers, or culverts, within such length; and no addition to such length because of the guniting of manholes and structures to one foot above the crown.

## **Section 319**

### **Corrugated Metal Pipe Culvert**

319.01 GENERAL.--The Contractor shall furnish and install galvanized corrugated metal pipe culvert, complete with coupling bands, paving, coating, lining, fittings and end sections, as applicable, all where and as shown on the plans, or where directed, including all excavating, lagging, backfilling, restoring pavement, and other necessary, or required, Incidental Work.

319.02 MATERIALS.--Corrugated metal pipe materials shall be galvanized and shall conform to the specifications of AASHTO Designation M 36.

The paving of inverts, bituminous coating and lining of pipes shall conform to the specifications of AASHTO Designation M 190.

319.03 IDENTIFICATION.--Each section of a pipe shall bear the name of the sheet manufacturer, the brand, or trade mark, and the gauge. This identification shall be stamped on the sheets by the manufacturers of the sheet. Pipe having any sections not so stamped shall be rejected. The manufacturer of the pipe shall roll the sheet so that the identification shall appear on the outside of each section.

319.04 MANUFACTURE.--All pipes shall be circular unless otherwise specified, of lap joint construction, and all joints shall be tightly fabricated by riveting, welding, or using a continuous lock seam so that the jointed pipe shall be straight and rigid.

The corrugations shall be not more than 2-3/4 inches wide and not less than  $\frac{1}{2}$  inch deep.

**319.05 DIMENSIONS AND WEIGHT.**—The sheet length before forming, the gauge of the uncoated metal, and the weight per foot of the finished pipe, shall not be less than shown in the following Table. A maximum variation of plus or minus 5 percent will be allowed from the weight specified in the Table.

Nominal Diameter Inches	Length of Sheet Before Forming-Inches	Min. Gauge U. S. Standard Uncoated Metal	Weight per Foot Finished Culvert-Pounds
12.....	41	16	10.8
15.....	50	16	13.1
18.....	60	16	19.3
24.....	79	14	25.4
30.....	98	14	43.6
36.....	117	12	52.0
42.....	136	10	75.6
48.....	156	10	88.1
60.....	298	8	136.8

Where pipe is to be placed under fills 20 feet or more in depth, the gauge of the sheets may be increased, such increase to be noted on the plans or in the Special Provisions.

**319.06 RIVETING.**—Rivets shall not be less than 5/16 inch in diameter for 14-gauge sheets or lighter, and they shall not be less than 3/8 inch for sheets heavier than 14 gauge. All rivets shall be thoroughly galvanized or sherardized.

Longitudinal joints shall be riveted in each outside groove, and for pipes of 30-inch diameter or larger, double riveted in each outside groove. In the transverse joints, rivets shall be placed uniformly not more than 6 inches apart.

Round heads of rivets shall have a diameter of not less than 1.5 times the diameter of the rivet, plus 1/8 inch, and flat heads shall have a thickness of not less than 3/5 of the diameter of the rivet.

**319.07 COUPLING BANDS.**—Field connections shall consist of bands not less than 12 inches in width, made from the same material as the pipe. They may be fitted with malleable cast iron lugs, or with angles having minimum dimensions of 1½ inches x 1½ inches and of a length equal to the full width of the band, and provided with galvanized bolts not less than ½ inch in diameter. The coupling bands shall be fabricated so that connections may be easily made in the field. A continuous band-type neoprene gasket not less than 7 inches wide by 3/8 inch thick shall be placed between the coupling band and abutting sections.

**319.08 CONSTRUCTION.**—The pipe shall be carefully handled to prevent damage to the galvanizing, and shall in no case be dragged along the ground. Such damage will be sufficient cause for rejection of the pipe. If permitted by the Engineer, small areas, on which the gal-

vanizing is damaged or destroyed, may be repaired by the application of two coats of hot asphaltic paint. The pipe shall be laid on a 4-inch thick sand bed and the trench backfilled in accordance with Section 304.

319.09 PAYMENT.—Corrugated metal pipe culvert satisfactorily constructed, complete, in place, as specified, will be paid for at the price bid per linear foot, measured horizontally along the centerline of culvert between the outside surfaces of structures, or to the limits as constructed, as applicable.

## **Section 320**

### **Brickwork**

320.01 GENERAL.—The Contractor shall do all brickwork, as specified, including all Incidental Work, necessary or required, for a complete, satisfactorily constructed masonry structure, where and as shown on the plans, or where directed.

Brickwork shall be done in accordance with the requirements of Section 424 and these specifications.

Mortar for brickwork shall be Class "B" or "C" as required by Section 900.09 and these specifications.

320.02 BRICK.—Brick shall conform to the requirements of ASTM "Standard Specifications for Building Brick (Solid Masonry Units Made from Clay or Shale)," Designation C 62, Grade MW.

320.03 CONSTRUCTION.—Excavations for brick shall be sufficient to leave a clear space of not less than 6 inches between the brickwork and the side of the excavation or lagging, to give ample room for plastering.

The brick shall be clean and well wetted before being laid, and every brick shall be laid in a full joint of mortar on bed, end, and side in one operation. Every fifth course of brick shall be a header course, and vertical joints shall be broken. Horizontal mortar joints shall be as uniform as possible, and shall not exceed  $\frac{3}{8}$  inch in thickness. The bottom of the structure shall consist of a first course of brick laid flat and close on an even surface. This course shall be grouted with thin grout composed of equal parts cement and sand.

Subsequent courses shall be laid in mortar as hereinbefore specified.

Particular care must be taken in forming the channels and shelves of the structures along pipe sewers; they shall be built in strict accordance with the plans, and must conform to the bottoms of the existing sewers. Brick channels shall be built of selected bricks set on edge, laid in Class "C" mortar, and well bonded. The structure floor and the channels shall be plastered with Class "C" mortar  $\frac{1}{2}$ -inch thick, the channels being finished to a true and smooth circular section.

A bull's eye with one rowlock course of brick shall be built into the structure for each entering pipe.

The joints in the brickwork on the inside of the structure shall be neatly struck, and the outside shall be plastered with Class "B" mortar at least  $\frac{1}{2}$  inch in thickness.

When a brick invert is specified, the brick shall be vitrified brick, and shall be placed as soon as the concrete is sufficiently set, though not less than twenty-four (24) hours after the placing. The brick shall be laid with the better surface exposed, in a full joint of mortar on bed, end, and side in one operation.

The Contractor shall construct brick inverts of new sewers to conform to the inverts of existing sewers so as to provide smooth, straight-line changes in invert grades and smooth flow surfaces.

The bricks shall be laid as stretchers, and shall break joints with those of the adjoining courses. The courses shall be kept straight and parallel to the axis of the sewer, and at a true grade, by the use of a template.

Brickwork shall not be constructed upon a concrete foundation until at least twenty-four (24) hours after such foundation has been placed. No brick shall be laid in water, nor shall water be permitted to stand or run on any brickwork until the mortar has thoroughly set.

Upon completion, brick masonry shall be kept continuously damp for at least two (2) days.

320.04 PAYMENT. --Brickwork shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **Section 321**

### **Side Sewer Trap**

321.01 GENERAL. --The Contractor shall furnish and install new vitrified clay pipe side sewer traps, complete with vitrified clay air vent risers, cast iron inlet frames with galvanized steel gratings, fittings, connections, extensions, and appurtenances; and including excavating, backfilling, restoring pavement and all other Incidental Work, necessary or required, for a complete, satisfactory installation, where and as shown on the plans, or where directed.

Fittings and soil pipe extensions on the house side of the trap connecting the trap to existing facilities shall be of the same type material as existing facilities or of vitrified clay pipe. Extensions connecting side sewer traps to existing facilities shall not extend beyond the property line.

321.02 INSTALLATION. --Traps shall have spigot ends and connections shall be made with "Band Seal" couplings as manufactured by the Mission Clay Products Corporation, or an approved equal.

321.03 PAYMENT. --Side sewer traps satisfactorily constructed complete, in place, as specified, will be paid for at the unit price bid therefor.



## **PART IV**

### **STRUCTURES**

#### **Section 400**

##### **Furnish Test Boring Equipment**

**400.01 GENERAL.**—The Contractor shall furnish and maintain at the site, and subsequently remove as his property, all equipment and appurtenances and shall do all related Incidental Work, all as required to satisfactorily make the test borings where shown on the plans, or where directed, and procure the specified samples.

The Contractor shall include the cost of moving and setting up the equipment at the various boring locations in the price bid to furnish test boring equipment.

The equipment shall have a positive means of continuously determining the pressure on the bit during drilling, except that when a churn drill is used such means will not be required and in lieu thereof the weight of the bit and stem shall be made known to the Engineer.

Test boring equipment used prior to determination of the ground water level shall be capable of satisfactorily drilling each boring to such elevation without the introduction of water into the boring.

**400.02 PAYMENT.**—Furnish test boring equipment will be paid for at the lump sum price bid therefor, to satisfactorily furnish, maintain, and remove the equipment and appurtenances as specified.

#### **Section 401**

##### **Test Borings**

**401.01 GENERAL.**—The Contractor shall do borings where shown on the plans, or where directed; including furnishing and installing casings, assisting in keeping records, covering and backfilling borings and excavations, and all other Incidental Work, all in accordance with the requirements set forth herein.

Borings shall be made vertically and shall be not less than 6 inches in diameter, unless otherwise specified. Rock borings shall be not less than  $2\frac{1}{2}$  inches in diameter. Auger borings shall be not less than one inch in diameter.

Boring to, and the determination of, ground water level at each boring shall be accomplished before the introduction of any water into the boring.

Jetting will not be allowed, except through fill below the ground water level.

To reach the directed depths of borings, the Contractor shall drill through all encountered obstructions, such as boulders, concrete, and other hard materials.

The Contractor shall, by bailing and other means, keep each boring properly clean and free of loose materials and debris, as necessary, so that the satisfactory procurement of samples is not hindered.

Any boring from which sufficient information has not been procured because of defective, improper, or otherwise unsuitable equipment, or has not been procured because of the failure of the Contractor to obtain the required satisfactory samples shall be considered an unsatisfactory boring and shall be supplemented by an additional boring or borings at that location, as necessary, to satisfactorily obtain the sufficient and proper equivalent soil information and samples intended from the original boring.

401.02 CASING.--Borings, in which strata is encountered which caves or swells into the boring, shall be suitably cased to the extent of such strata. When perforated casing is required the area of the perforations shall be not less than 5 percent of the surface area of casing. Perforations shall be slots, 1/8-inch wide.

Upon completion of the test boring work, casings may be withdrawn as the property of the Contractor.

401.03 BORING RECORDS (LOGS).--The Contractor shall assist the Engineer in sampling drilling returns and obtaining data for the boring log at each boring location, including ground surface elevations referred to a suitable bench mark, depths, thicknesses and classifications of strata, as well as moisture content, ground water level, degree of compactness of soil as indicated by resistance to penetration, location and nature of obstructions, and other pertinent information. The data shall also include the information required for the gummed label for each retainer or other sample container.

The Contractor shall furnish the gummed labels in a size proper for the retainers, jars, and core boxes. The labels shall be typed or imprinted with the following form, as applicable:

PROJECT NAME (Typed in)

Date \_\_\_\_\_

Test Hole No. \_\_\_\_\_ Sample No. \_\_\_\_\_

Depth \_\_\_\_\_

\_\_\_\_\_ blows \_\_\_\_\_ penetration \_\_\_\_\_ recovered

\_\_\_\_\_  
Description of Recovered Material

The Engineer will enter the required information on the labels and and place them on the containers.

401.04 COVERING AND BACKFILLING BORINGS AND EXCAVATIONS.—The Contractor shall cover boring holes and excavations unattended by responsible personnel and prevent removal or displacement of such covers by unauthorized persons. The method and manner of covering must be approved by the Engineer. Leaving boring equipment over the hole, using a sandbag weighted cover, plugging, or using some other adequate method of securing the hole or excavation may be acceptable depending upon field conditions.

Plugs, if used, shall be of concrete or wood, shall be installed flush with the pavement, and shall be secured by approved means.

Upon completion of the work, the Contractor shall remove all plugs, covers, and weighting materials from the site as his property.

Immediately upon completion of all work, including the procurement of all information and samples, at each boring and excavation location, the Contractor shall completely and solidly backfill that boring or excavation. Backfill shall consist of approved site excavated materials or sand compacted by flooding. Flooding will be prohibited where facilities or structures might be damaged or adjacent materials softened by the applied water.

401.05 RESTORING PAVEMENT AND OTHER IMPROVEMENTS. The Contractor shall restore pavement and other improvements in accordance with the requirements of Section 108.09.

401.06 PAYMENT.—Test borings satisfactorily completed, as specified, will be paid for at the applicable price bid per linear foot as set forth in the Proposal.

The quantity to be paid for will be the aggregate vertical distance of test borings measured from the existing pavement surface or ground surface, as applicable, at each boring, to the directed and drilled depth of that boring measured along the withdrawn boring rods to the point of the boring or drilling tool.

Where a boring has been considered unsatisfactory and been supplemented by additional borings, as necessary to obtain sufficient and

proper samples, such combination of borings at that location will be considered one (1) boring and the quantity to be paid for will be the single distance from the top to the directed drilled depth of the deepest boring of such combination of borings.

## Section 402

### Soil Sample in Retainer

**402.01 GENERAL.**—The Contractor shall procure and deliver soil core samples in retainers taken at boring locations shown on the plans, or where directed, from strata or depths determined by the Engineer, and shall do all related Incidental Work, as specified.

In taking soil samples from test borings, every precaution shall be taken to make the samples truly representative of the materials encountered as they exist in the stratum from which obtained.

The Contractor shall drive and obtain core samples in retainers at the depths directed by the Engineer. Two samples in two separate retainers will be required for each driving and subsequent removal operation.

Boring records (logs) shall be in accordance with Section 401.03.

The Contractor shall deliver the samples to the Bureau of Engineering, where directed, within 24 hours of the time of removal from the boring.

The City will test the samples at no cost to the Contractor.

**402.02 SAMPLE RETAINERS.**—Sample retainers shall be No. 20 B & S gauge (.032 inch) seamless brass, 2½ inches O.D. by 5 inches long and shall be equipped with removable, air tight, caps.

Retainers which contain satisfactory samples will become the property of the City.

**402.03 CORE SAMPLING TOOL.**—The core sampling tool shall be designed to procure in one driving and subsequent withdrawal operation not less than 2 complete samples, each in a separate sample retainer. The size of the core sampling tool in relation to the size of the boring, or casing if any, and the driving procedure for the core sampling tool shall be such that there is sufficient annular space to prevent binding of the tool during driving.

Accumulations of sludge, cuttings, or other material which will cushion or dampen the action of the driving equipment shall be removed.

**402.04 PROCUREMENT OF SAMPLES.**—The core sampling tool shall be driven by a hammer of sufficient weight; in no case less than 300 pounds. The hammer shall impart not less than 8,100 inch-pounds of energy per blow to the sampling tool and, in the course of its drop, shall be unimpeded. The same weight of hammer and the same height of drop shall be used to procure all samples.

Any core sample with an undisturbed length, as determined by the Engineer, equal to at least 80 percent of the length of the retainer will be considered acceptable for payment. Both samples from each driving and withdrawal operation will be paid for if they meet with the aforementioned undisturbed length requirements.

The materials, in any and all of the retainers, which have been determined unacceptable for payment by the Engineer, and any materials in the core sampling tool, shall be the property of the City and may be retained by the Engineer at his option. Such materials retained by the City need not be capped, sealed nor otherwise prepared as specified for accepted samples. The procurement of such materials not accepted as undisturbed samples, and the furnishing of containers therefor, excluding samples in jars, will be considered Incidental Work.

402.05 PAYMENT. --Soil core sample in a single retainer satisfactorily procured and delivered, as specified, will be paid for at the unit price bid therefor.

No payment will be made for an unsatisfactory sample.

## **Section 403**

### **Sample in Jar**

403.01 GENERAL. --The Contractor shall procure and deliver soil samples in standard type jars, furnished by the Contractor, taken at boring locations shown on the plans, or where directed, from strata or depths determined by the Engineer, and shall do all related Incidental Work, as specified.

Boring records (logs) and labels shall be in accordance with Section 401.03.

The Contractor shall deliver the jar samples to the Engineer at the site at the time the sample is obtained.

403.02 PAYMENT. --Sample in jar satisfactorily procured and delivered, as specified, will be paid for at the unit price bid therefor.

## Section 404

### Rock Core Sample

404.01 GENERAL. --The Contractor shall procure and deliver rock core samples taken at the boring locations shown on the plans, or where directed, from strata or depths determined by the Engineer, and shall do all related Incidental Work, as specified.

A diamond core bit and a single or double-tube core barrel shall be used of such size as to obtain core samples no less than one and three-sixteenths (1-3/16) inches in diameter, except that double-tube core barrels shall be used should the sample recovery in single-tube core barrels be poor, as determined by the Engineer.

The core sample shall be approximately 18 inches long and shall be labeled and stored before the boring is continued. Core samples shall be carefully handled to ensure their proper identification and preservation.

The Contractor shall regulate the speed of the drill, rate of feed, and pressure on the bit to ensure the maximum percentage of core sample recovery.

Core samples shall be placed in suitable core boxes, so partitioned that separate samples will not become mixed, and spacer blocks shall be inserted and properly labeled with the designation of the rock boring location and depth of the sample, so that separate samples may be identified easily.

Each core box shall be properly, clearly, accurately and permanently labeled, showing the project name and designations of the rock borings.

Boring records (logs) and labels shall be in accordance with Section 401.03.

The Contractor shall deliver the samples in the core boxes to the Bureau of Engineering, where directed, within 24 hours of the time of removal from the boring.

404.02 PAYMENT. --Rock core sample satisfactorily procured and delivered, as specified, will be paid for at the unit price bid therefor.

## Section 405

### Pavement Design Sample

405.01 GENERAL.—The Contractor shall procure and deliver pavement design samples from the locations shown on the plans, or where directed, from depths determined by the Engineer, and shall do all related Incidental Work, as specified.

Pavement design samples, consisting of subgrade materials for proposed pavements, shall be procured by auger boring, excavating, or other approved means and shall consist of 70 lbs. of soil per sample placed in a suitable container.

Boring records (logs) and labels shall be in accordance with Section 401.03.

The Contractor shall deliver the samples to the Bureau of Engineering, where directed, within 24 hours after they are obtained.

405.02 PAYMENT.—Pavement design sample satisfactorily procured and delivered, as specified, will be paid for at the unit price bid therefor.

## Section 406

### Site Preparation for Structures

406.01 GENERAL.—The Contractor shall prepare the site by clearing, grubbing, grading, and removing existing structures, all where and as shown on the plans and as necessary to prepare the site and bring the ground surfaces to the required elevations.

Clearing and grubbing shall be done as specified in Section 200, and shall include soil sterilization, removing and disposal of materials, and all other work specified in such Section.

Common excavation and construction of compacted embankment shall be done in accordance with the requirements of Sections 203 and 206.

The Contractor shall submit in writing to the Engineer for approval, the sequence of operations that he intends to use to excavate slopes steeper than 2 vertical : 1 horizontal, or slopes subject to sliding. The submittal, in addition to the sequence of operations, shall list the precautionary measures the Contractor intends to take to prevent earth slippage of the ground adjacent to the excavation and to prevent unauthorized entry to the area of operation.

The Contractor shall not remove from the work, nor waste, any site excavated material that is in accordance with the specified require-

ments for backfill, fill, and embankment, except that quantity thereof, if any, that may be in excess of the total quantity required to complete all backfilling and embankment.

406.02 REMOVAL OF STRUCTURES. --The Contractor shall excavate, remove, and dispose of, existing plain and reinforced concrete structures or parts thereof where shown on the plans and where necessary for the required construction, and shall construct the required backfill.

The Contractor is cautioned that there may have been changes in the existing structures during and since the time of original construction; the City therefore does not guarantee the accuracy nor completeness of any plans or information regarding such structures.

Portions of footings and structures that are to remain in place and be used in construction, damaged, destroyed or removed by the Contractor, shall be satisfactorily reconstructed or replaced by him at no cost to the City.

406.03 PAYMENT. --Site preparation for structures shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **Section 407**

### **Structural Excavation**

407.01 GENERAL. --The Contractor shall do all excavating necessary to obtain the subgrade required for the foundations, footings, slabs or other structural components of the contract work, including constructing related drainage facilities and doing other Incidental Work, all where and as shown on the plans and in accordance with the requirements set forth herein.

Excavation for the footing or foundation of any structure shall extend to undisturbed material. The last three inches of material excavated for footings and foundations shall be loosened and removed with hand tools to leave an undisturbed bed.

Where the slope of the bottom of the required excavation for footings or foundations is greater than 1 vertical : 10 horizontal, the Contractor, at no additional cost to the city, shall excavate "step footings" having a 4'-0" minimum width of step and 2'-6" maximum depth.

The Contractor shall submit to the Engineer, for approval, the sequence of operations whenever it is necessary to excavate adjacent to and below existing foundations of other structures to remain.

Excavations shall have vertical sides in accordance with Section 300.04.

Excavations below subgrade for footings and foundations shall be

backfilled to the required subgrade by the Contractor at his own expense. Where required by the Engineer, such backfilling shall be with Class "D" concrete.

407.02 REMOVAL OF SUBSURFACE OBSTACLES.—Subsurface obstacles, regardless of size, shape, or material, and whether or not shown on the plans or specified, if encountered within the limits of excavation required for the work shall be removed by the Contractor as Incidental Work as set forth in Section 108.05.

Within areas where the required subgrade is that for a structure or like facility, or where excavation is to graded ground upon which no construction is called for under the contract, removal of subsurface obstacles shall be to not less than one foot below such subgrade or ground surface. Where the surface serves as subgrade for footings or foundations, the Engineer may require that backfill of the voids left by the removal of subsurface obstacles be with Class "D" concrete.

407.03 EXCAVATION OF UNSOUND SUBGRADE MATERIAL.--The Contractor shall excavate unsound subgrade material and construct satisfactory compacted backfill in place thereof, in accordance with the provisions of Section 300.06.

407.04 DEWATERING OF EXCAVATIONS AND DISPOSAL OF WATER

General.—The Contractor, in accordance with the requirements of Section 108.06, shall keep excavations dry, remove and dispose of all water and seepage therefrom, and shall provide, maintain and operate all pumping equipment required for such purpose during the time concrete or other work is being placed and thereafter as required for the protection of the work. The aforesaid requirements shall be observed as necessary or required prior to the completion of drainage facilities specified or ordered to be constructed under the contract.

Dewatering and the rate and manner of lowering the water table shall be such as to minimize any settlement that might be caused thereby.

Pumping operations for excavations shall be continuous and satisfactory from the time drawdown is first accomplished until all the concrete has been placed. The Contractor shall not allow his pumping operations to be interrupted; shall take adequate precautions to such end; and shall assume full responsibility for any damage that occurs due to a fluctuating water table in the area influenced by the dewatering.

Pumping from the interior of an excavation shall be done in such manner that there will be no movement of water through any fresh concrete, and for a period of 24 hours after a pour shall be done from a suitable sump separated from the concrete work by a watertight wall or other effective means.

The Contractor shall at all times, by the institution of proper precautions, prevent hydrostatic uplift and flotation of the work.

Drains.—When specified, shown on the plans, or required by field conditions, the Contractor shall construct permanent or temporary drains and appurtenances adequate to keep excavations and subgrades

sufficiently dry to permit proper conduct of his operations. Unless otherwise specified, pipe to carry such drainage shall be perforated bell and spigot vitrified clay pipe, not less than 6 inches in diameter, and shall be placed with the perforations facing down. The drains shall be placed in crushed rock or other suitable filter bed extending at least 6 inches laterally from each side of the pipe and 12 inches vertically above the top of the pipe, with an approved waterproof membrane thereover and acceptable backfill over the membrane.

407.05 PREPARATION OF SUBGRADE.--Preparation of subgrade shall be done in accordance with the applicable requirements of Section 204.

Subgrade shall be prepared to provide a satisfactory, uniform and compacted bearing surface for the construction.

Subgrade surfaces on which pile-supported concrete is placed shall be adequately prepared to assure proper support for the placed concrete until such concrete has sufficient strength to span and be supported solely by the piles.

407.06 DISPOSAL OF EXCAVATED MATERIALS.--The Contractor shall remove excavated materials from the site as his property, and such removal shall be in accordance with the provisions of Sections 203.04 and 108.11.

407.07 PAYMENT.--Structural excavation shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **Section 408**

### **Sheet Piling, Lagging, Bracing and Cofferdams**

408.01 GENERAL.--The Contractor shall furnish, install and maintain such sheet piling, bulkheading, cribbing, timbering, lagging, underpinning, shoring, bracing, cofferdams, and other temporary construction as necessary to support the sides of excavations and any adjacent structures, and to prevent any movement of the ground or danger to life or property, and such construction shall be carried to adequate depths and heights and made as tight as necessary for the proper performance of the work.

Sheet piling, lagging and bracing shall be in accordance with the applicable requirements of Section 301.

Unless otherwise specifically approved for each particular location by the Engineer, struts, braces and other temporary construction shall be so constructed as to not pass through volumes to be occupied by concrete structures leaving openings in the concrete which must be subsequently filled.

When specified in the Special Provisions the Contractor shall submit detailed drawings of all such aforementioned temporary construction to the Engineer for approval, and shall not start any part of the temporary construction prior to the receipt of such approval. The approval of such drawings by the Engineer shall in no way relieve the Contractor of any responsibility or liability, including that for structural adequacy, under the contract, and he shall take all precautions he considers proper for the protection of the public and the work.

**408.02 PAYMENT.**—Sheet piling, lagging, bracing, and cofferdams shall be constructed as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 409

### Structural Backfilling

**409.01 GENERAL.**—The Contractor shall furnish, place and compact backfill from site excavated earth and concrete materials, all as required to bring all surfaces to the lines, grades and cross sections shown on the plans and cross sections, including loading, hauling, stockpiling, depositing, watering, and compaction, and all other Incidental Work, all in accordance with the requirements set forth herein.

**409.02 BACKFILL MATERIALS.**—Backfill shall consist of approved material, free from debris, wood, and other organic, unsound or deleterious matter.

The composition of backfill materials shall be at least equal in quality to that of the native material existing at the site. Materials, including those excavated at the site, yielding a maximum dry density of less than 112 pounds per cubic foot, when tested in the laboratory in accordance with the compaction test described in Section 205.01, shall not be used as backfill or fill.

The material used for backfill behind or around structures and appurtenant facilities shall have a sand equivalent value of not less than 30. The percentage composition by weight shall conform to the following grading:

<u>Sieve Size</u>	<u>Percentage Passing</u>
3-inch .....	100
No. 4 .....	35 - 100

Lumps, rocks and concrete pieces measuring 3 inches or less in greatest dimension may be incorporated into backfill; and, if contained in backfill more than 4 feet deep, and satisfactorily distributed in earth or other fine materials, pieces not greater than 6 inches in greatest dimension may be so incorporated, provided that such latter pieces be not placed within 3 feet of finished grade or subgrade, nor in areas where piles are to be driven or drilled.

Rocks, concrete, or hard lumps of earth larger than allowed shall be broken up before compacting.

409.03 PERVIOUS BACKFILL MATERIAL.--Material used for specified pervious backfill behind retaining walls and around drains shall consist of gravel, crushed gravel, crushed rock, natural sand, manufactured sand, or combinations thereof, the percentage composition by weight of which shall conform to the following grading:

<u>Sieve Size</u>	<u>Percentage Passing</u>
2 inches .....	100
No. 50 .....	0 - 100
No. 100 .....	0 - 8
No. 270 .....	0 - 4

409.04 PROCEDURES. --All sand backfill, except that behind abutments and except pervious material and sand behind retaining walls, shall be flooded or jetted, or compacted by other approved means, in horizontal layers not more than 3 feet thick. Flooding shall be such that, after 5 minutes, water will show on the surface.

Backfilling for facilities in street areas such as sewers, sewer structures, and the like, shall be as specified in Section 304.

Flooding or jetting of sand will be prohibited where facilities or structures might be damaged, or adjacent materials softened, by the applied water.

All backfill, other than sand, shall be placed in horizontal layers not more than 8 inches thick before compaction, and each layer shall be satisfactorily compacted as and to the degree specified in Section 205.02, by means of suitable mechanical equipment. Flooding or jetting, in this case, will not be allowed.

Pervious material and sand behind retaining walls and abutments shall not be flooded or jetted but shall be deposited in 8-inch layers and compacted with mechanical vibrators.

Compaction of sand and of sand and pervious material backfill shall be to the degree specified in Section 205.02.

In all cases, each layer of material shall be satisfactorily compacted before placing the next layer thereon.

Backfilling above or against any facilities to be constructed under the contract shall not commence until after such facilities have been properly constructed and inspected. Further, backfilling above or against poured-in-place reinforced concrete structures shall not commence until the concrete has attained a compressive strength of at

least 2,000 pounds per square inch. Backfill shall be placed in a manner to not disturb or damage such facilities or structures, nor subject them to unbalanced loads or forces.

Backfill in front of a retaining wall shall be placed and compacted prior to backfilling behind such wall.

Backfilling behind the retaining walls shall not commence until a minimum of fourteen (14) days have elapsed after construction of the wall.

At the time of compaction, materials to be incorporated in backfill, except sand, shall have the proper uniform moisture content required to obtain the specified relative compaction. The Contractor shall water, or do whatever spreading, mixing and stockpiling is necessary to dry such materials, as the case may be, in order to obtain such proper moisture content.

The Contractor's attention is directed to the possibility of excessive lateral pressure on, and resultant damage to, retaining walls; he shall, therefore, exercise care in properly placing the backfill behind such walls. The use of heavy compacting equipment in areas immediately behind retaining walls will not be allowed, and all such compaction shall be done with portable equipment.

409.05 PAYMENT.—Structural backfilling shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

**Section 410**

**Furnish Pile-Driving Equipment**

410.01 GENERAL.—The Contractor shall furnish and maintain at the site, and subsequently remove from the site as his property, all equipment, and appurtenances, including spuds, jets, and pumps, and shall do all Incidental Work, all as required to satisfactorily drive all piles furnished under the contract, all in accordance with the requirements set forth herein.

The Contractor shall include the cost of moving the pile-driving equipment between the various pile locations in the price bid for furnishing pile-driving equipment.

For the purpose of computing progressive payments, the work shall be prorated as set forth in the following table:

- a) Furnish all necessary pile-driving equipment at the site and satisfactorily driving the first pile. .... 60%
- b) Maintaining all necessary pile-driving equip-

ment and completing the satisfactory driving of all piles under the contract. ....	30%
c) Removing all pile-driving equipment from the site. ....	10%
Total	100%

For purpose of payment, no work shall be considered performed until the first pile has been satisfactorily driven. The work allocated under b), above, for maintaining the pile-driving equipment and completing all pile-driving shall be prorated in accordance with the percentage of the number of piles satisfactorily driven.

410.02 PILE DRIVER.—The pile driver shall have fixed leads which shall be capable of guiding the hammer from the highest to the lowest point of travel and holding the pile firmly in axial alignment with the hammer. The leads shall be secured to the body of the crane or supporting tower by rigid members in a manner that will prevent movement and maintain alignment of the leads during driving operations.

The pile hammer shall be an approved steam, air, or diesel hammer, and shall be of such weight that when operating at the rated number of blows per minute specified by the manufacturer it will be capable of delivering to the pile at least 15,000 foot pounds of energy per blow. The adequacy of the hammer for a particular job shall be subject to approval by the Engineer. The hammer shall be in first-class operating condition and be capable of developing the energy rated by the manufacturer. Improperly or inefficiently operating hammers shall not be used to drive piles.

Suitable anvils, driving caps, or cushions shall be used to prevent damage to the pile butts.

Equipment for the driving of test piles shall be the same as that for driving all other piles under the contract.

410.03 FOLLOWER.—The use of a follower will be permitted provided the follower is of the type that will adequately and properly, as determined by the Engineer, transmit the energy of the hammer blow to the pile head. The follower shall have minimum length of 20 feet, and its average weight shall not be less than 80 pounds per foot. The use of a timber follower of any type will not be permitted.

The Contractor shall submit to the Engineer for approval complete detailed data on the follower he intends to use, prior to commencement of use thereof.

Further, if the Contractor proposes to drive piles using a follower, he shall drive all piles, including test piles, using the same follower.

410.04 JETTING EQUIPMENT.—If jetting equipment is specified, it shall be capable of delivering, and shall be outfitted with, the following:

- 1) A constant supply of water at 300 to 500 gallons per minute, as necessary, at the nozzle of the jet pipe;
- 2) A minimum pressure of 250 psi at the nozzle of the jet pipe;

- 3) A jet nozzle of 3/4 inch to 1 inch diameter with four to six side holes 1/8 inch in diameter, evenly spaced around the nozzle;
- 4) Sufficient jet pipe to reach the specified depth;
- 5) Jet pipe permanently and visibly marked in 5-foot increments commencing at 40 feet from the tip of the nozzle.

The pressure and the discharge rate of the water at the jet shall be adequate to freely erode materials adjacent to the pile.

410.05 SPUD.—If a spud is used, the size and the strength thereof shall be adequate to drive through miscellaneous fill materials such as gravel, small boulders, rubble, and timbers.

410.06 PAYMENT.--Furnish pile-driving equipment will be paid for at the lump sum price bid to satisfactorily furnish, maintain and remove the specified equipment and appurtenances.

## Section 411

### Driving Piles

411.01 GENERAL.—The Contractor shall drive piles, including all test piles and all spliced piles, where and as shown on the plans, or where directed, and shall do all Incidental Work, all in accordance with the requirements set forth herein.

411.02 BORING DATA.--In most cases, prior to pile driving, the City will have completed under separate contracts soil borings in close proximity of the work. Generally in such cases, the logs and locations of the borings and the results of soil tests made on samples taken during the borings will be shown on the plans. Jar samples of the materials encountered may also be allowed to be inspected. In the event such information is made available to the Contractor, it shall be understood that the City will assume no responsibility for the accuracy of such information nor for any deductions or conclusions that the Contractor may make therefrom.

411.03 OBSERVATION AND RECORDING OF PILE BEHAVIOR.—The Contractor shall provide the Engineer with every reasonable facility for properly observing and recording the behavior of each pile during the entire driving operation, including allowing access to the behavior information recorded by the Contractor. The Contractor shall furnish to the Engineer spray cans of paint for marking all piles for blow count records.

When driving is interrupted before final penetration is reached, the record for penetration shall not be taken, except as otherwise directed by the Engineer, until twelve (12) inches of penetration have been obtained on resumption of driving.

411.04 EXISTING PILES. --Should existing piles conflict in location with piles to be driven, substitute pile locations will be determined by the Engineer. Piles shall be driven at such substitute locations at no extra cost to the City.

411.05 OBSTRUCTIONS. --If, during driving, an obstruction, such as a large boulder, prevents further driving or jetting of a pile, the pile may be ordered abandoned by the Engineer and another pile ordered by him to be driven close by. A pile so abandoned shall be cut off as Incidental Work one foot below normal cut-off elevation. Payment, under the appropriate Bid Item, for the furnishing of each such abandoned pile will be for the ordered length or for the length from tip to cut-off, as applicable. Payment for the driving of each such pile will be made under the appropriate Bid Item.

411.06 DRIVING. --Each pile shall be driven plumb for vertical piles and at batter indicated for batter piles, and shall be located true to line and spacing as shown on the plans. Each pile, at cut-off elevation, shall not be more than 4 inches out of place. If such allowable deviation is exceeded, the pile shall be abandoned and another driven, unless the Contractor constructs, on top of the driven pile, an approved equivalent support. All such abandoned piles or additional construction or other work caused by piles being out of place, shall be at the sole expense of the Contractor.

Driving of piles, steel pipe, or steel shells within 50 feet of concrete structures or cast-in-place concrete piles will not be permitted until the concrete in such structures or piles has attained a compressive strength of at least 2,000 pounds per square inch.

Piles, steel pipe, or steel shells shall not be driven until the excavation at the pile locations has reached cut-off elevation unless otherwise set forth in the Special Provisions or permitted by the Engineer, in which case passage for the piles, pipe, or shells through the overburden must be provided by spudding or boring prior to driving.

All steel pipe or steel shells shall be driven initially to a blow count of 10 blows per inch. After the specified jetting of any pipe or shell, it shall be driven to a final blow count of 10 blows per inch.

Each timber pile shall be driven to at least its full ordered length less one foot, unless otherwise ordered by the Engineer, and in no case shall the driving thereof terminate with the pile tip in a sand stratum underlain by weak, highly compressible soils, all as determined by the Engineer. Where a sand stratum, offering high resistance to driving, is encountered above a weak soil layer, jetting, as required in the Special Provisions, shall be employed to facilitate the driving of the pile through the sand stratum.

In all cases in the driving of test piles, the specified jetting shall be employed as necessary, as determined by the Engineer, for the full ordered length or to the elevations set forth in the Special Provisions or shown on the plans.

411.07 SPUDDING. --In order to decrease the frictional resistance of timber piles, or other friction type piles, the Contractor shall, by

means of spudding, provide holes completely through the overburden to the cut-off elevation, or if specified, to the elevation set forth in the Special Provisions. The minimum diameter of each spudded hole shall be 2 inches greater than the butt diameter of the pile to be driven.

The hole shall be cleared sufficiently of materials so as to allow the placing of the tip of the pile at the bottom of the hole with the aid of no more than the weight of the hammer on the pile. Any hole which does not permit such placing of the pile shall be respudded or redrilled, and, if necessary, repeatedly respudded or redrilled and/or protected by the use of casing, to the extent that the hole will be sufficiently clear to allow the placing of the pile in the spudded hole in the manner specified.

In the event spudding is impracticable due to large obstructions, the Contractor shall furnish and operate, at his own expense, the necessary drilling apparatus and drill holes, not less than the butt diameter plus 2 inches, in lieu of spudded holes.

411.08 JETTING.—In order to obtain the required penetration, when specified in the Special Provisions, the Contractor shall supply and operate water jets with adequate pumping equipment. Jetting shall start only after "refusal" has been reached; "refusal" shall be defined as a blow count of 10 blows to the inch.

Where jets have been employed, they shall be withdrawn and jetting not permitted once the final bearing stratum has been reached.

Jetting shall be done with care so as not to loosen adjoining piles already driven. Piles that have lifted shall be redriven at the sole expense of the Contractor.

When jetting is specified, the Contractor shall continuously maintain on the pile driver, jet pipes and jetting equipment in good operating condition, so that they will be available for immediate use when necessary. No pile-driving will be permitted unless such jetting equipment is available, and the cost of any and all delays caused by non-compliance with this requirement will be at the sole expense of the Contractor.

Should City water from hydrants be required by the Contractor for jetting purposes, he shall first obtain written permission from the Chief of the San Francisco Fire Department, and shall then contact the Water Distribution Division Manager of the San Francisco Water Department for final approval.

411.09 UNSATISFACTORY PIPE, STEEL PIPE, OR STEEL SHELL.—Any pile, steel pipe, or steel shell misaligned or damaged as a result of the Contractor's operations to an extent that will make it incapable, in the opinion of the Engineer, of performing the function for which it was designed, will be considered unsatisfactory. Such unsatisfactory pile, steel pipe, or steel shell shall be withdrawn and removed by the Contractor as his property, or, if approved by the Engineer, abandoned with the upper section removed to at least one foot below the cut-off elevation.

The Contractor shall satisfactorily replace all such removed or

abandoned piles, steel pipe, or steel shells. Such satisfactory replacements will be paid for under the appropriate Bid Items therefor. However, as set forth under Section 411.10, no payment will be made for unsatisfactory piles.

411.10 PAYMENT.--Driving of a pile, satisfactorily as specified, will be paid for at the applicable unit price bid per pile as set forth in the Proposal, including test piles and spliced piles.

For the purpose of payment for driving, a spliced pile, regardless of length, the circumstances of splicing, and the number of component parts, will be considered a single pile.

In the event several length categories for driving are included in the Proposal, the length of a pile shall be as measured between the tip and the cut-off.

No payment will be made for furnishing, driving, withdrawing, removing, or abandoning unsatisfactory piles, steel pipe, or steel shells, which are defective, or damaged as a result of the Contractor's operations, or are otherwise unsatisfactory as set forth in Section 411.09. However, piles which during driving encounter obstructions will be paid for as set forth under Section 411.05.

## **Section 412**

### **Furnish Timber Pile**

412.01 GENERAL.--The Contractor shall furnish timber piles of lengths ordered by the Engineer, or specified, including certifying, handling, storing, treating, splicing, disposing of stubs and surplus piles, and doing all other related Incidental Work, all in accordance with the requirements set forth herein.

All timber piles shall be clean-peeled Douglas fir Class "A" piles in accordance with the requirements of ASTM "Standard Specification for Round Timber Piles," Designation D 25.

412.02 CERTIFICATION.--Certification, in writing, by an independent testing laboratory approved by the City, that the piles furnished are Douglas fir and conform to the specifications for Class "A" piles of ASTM Designation D 25, will be required prior to delivery at the site. Positive identification of each approved pile shall be effected by burning or indelibly imprinting a characteristic stamp or mark of the testing laboratory thereon at the time of inspection. Two copies of the certification for each shipment shall be delivered to the Engineer. No direct or additional payment will be made for the above certification, and the Contractor shall include all costs thereof in his bid prices.

412.03 CREOSOTING.—Timber piles, when specified in the Special Provisions or indicated on the plans to be treated, shall be pressure treated with creosote in accordance with Section 427. For spliced piles, treatment will only be required for the upper components. The heads of all treated piles shall receive a brush coat of creosote, in accordance with Section 427.09.

412.04 SPLICING.—Pile splices shall be in accordance with the details shown on the plans and will only be permitted to be used in the following instances:

- (1) When the length of pile, ordered by the Engineer, is 70 feet or longer, the Contractor, at his option, may use a spliced pile. For such spliced pile, only one splice will be permitted, and the splice shall be placed at least 30 feet below the the cut-off elevation, unless otherwise specified. In this instance, materials furnished for the pile splice, and the construction of the splice, shall be at the sole expense of the Contractor, and no direct or additional payment will be made therefore;
- (2) When a pile, whole, or spliced as permitted under (1) above, has been driven to its full ordered length without having reached the bearing result desired by the Engineer, the Engineer will order the splicing of an additional length of pile. In this instance, the ordered pile splice will be paid for as set forth under Section 414.

Tip diameters, of other than the lowest component, of a spliced pile shall be 11 inches.

412.05 CUT OFF AND EXTENSION.—Timber piles shall be cut off square at the elevation designated. Piles inaccurately cut off shall be replaced or, when permitted by the Engineer, shall be extended with approved reinforced concrete caps, all at the sole expense of the Contractor.

Extensions for piles, necessary as replacements for those portions of damaged piles which were cut off due to brooming or splitting, shall be constructed at the sole expense of the Contractor.

412.06 DISPOSING OF STUBS AND SURPLUS PILES.—After the completion of all pile driving operations, all timber pile stubs and surplus timber piles, except those marked by the Engineer to be retained by the City, shall remain the property of the Contractor and shall be disposed of by him as his property. The City will assume the responsibility for the loading and removal of those pile stubs and surplus piles to be retained by the City.

412.07 PAYMENT.—Timber piles, as specified, satisfactorily furnished at the site, will be paid for at the price bid per linear foot.

## Section 413

### Timber Test Piles

413.01 GENERAL.—When required in the Special Provisions, the Contractor shall drive timber test piles where shown on the plans, or where directed, and in accordance with the requirements set forth herein.

The Contractor shall furnish all equipment in accordance with Section 410, and timber piles in accordance with Section 412. He shall drive the timber test piles in accordance with Section 411.

The approximate locations and lengths of test piles to be driven shall be as shown on the plans and specified in the Special Provisions. From the results obtained in driving test piles, the Engineer will determine the lengths of all other piles to be used under the contract and will furnish to the Contractor the pile length list for the piles located between each four consecutive test piles within five (5) working days after the satisfactory driving of such test piles. Timber pile lengths, as measured from cut-off elevations, will be given in standard stock lengths and will include allowances for cut-offs as well as allowable variations in lengths set forth under ASTM Designation D-25.

Nothing in the above, however, shall be construed as preventing the Contractor, in the interest of expediting work, from supplying himself, in advance, at his own risk, with some piling at the job site to commence pile driving operations.

Test piles shall be so located that they may be cut off and become a part of the completed structure. Test piles shall be driven using the same type of equipment and the same procedures that will be used in driving all other piles under the contract.

If the information obtained from a required test pile is, in the opinion of the Engineer, inconclusive, he will order the driving of an additional test pile in the immediate vicinity at a location designated by him. Upon the completion of the driving of all test piles, unused additional test piles will be considered piles ordered from the pile list and payment will be made for the full ordered lengths of such unused test piles.

If, at the option of the Contractor, test piles are driven in the street area prior to excavation, each pile butt shall be driven or cut off below the existing street pavement grade, and immediately following the driving of the pile, the opening in the street shall be backfilled and topped with a minimum of 2 inches of temporary pavement. Such work shall be done as Incidental Work and no additional payment will be made therefor.

Test piles will be ordered in lengths measured from the cut-off elevations. If at the Contractor's option test piles are to be driven prior to excavation, allowance should be made for the additional lengths required, or a follower should be used. Such furnishing of

the additional lengths of piles, or the use of the follower shall be at the Contractor's sole expense and no additional payment will be made therefor.

413.02 PAYMENT.--Timber test piles will be paid for as set forth under Sections 410, 411 and 412, as applicable, and no direct or additional payment over and above that provided under such Sections will be made by virtue of any pile being a test pile.

## Section 414

### Ordered Timber Pile Splice

414.01 GENERAL.--In each instance where the length of a timber pile ordered by the Engineer is insufficient to attain the required bearing result and a splice is ordered by the Engineer, the Contractor shall furnish materials for and construct such ordered timber pile splice where and as shown on the plans and where directed, including doing all related Incidental Work.

In accordance with Section 412.04, approved timber pile splices constructed by the Contractor at his option for piles ordered to be 70 feet or longer will not be included for payment under this Section but shall be done as Incidental Work.

414.02 PAYMENT.--Ordered timber pile splice satisfactorily furnished and constructed, complete in place, as specified, will be paid for at the unit price bid therefor.

## Section 415

### Furnish and Construct Concrete-Filled Steel Pipe Piles

415.01 GENERAL.—The Contractor shall furnish and construct concrete-filled steel pipe piles where and as shown on the plans or where directed, including steel pipe, splices, concrete, reinforcing steel, welded steel end plates, and all other related Incidental Work, all in accordance with the requirements specified herein.

The Contractor shall drive steel pipes in accordance with Section 411. Each steel pipe shall be driven to the required bearing value before being filled with concrete.

After being driven and prior to the placing of reinforcing steel and concrete, each steel pipe shall be examined for damage or reduced diameter at any point. Any pipe improperly driven or broken, or which shows partial collapse to an extent that will materially decrease its bearing value, will be rejected as unsatisfactory and shall be replaced by the Contractor.

Driven pipe shall be free of water before reinforcing steel and concrete are placed.

The Contractor shall have available at all times a suitable light for inspecting the entire length of each pipe before placing reinforcing steel and concrete.

415.02 STEEL PIPES.—Steel pipe piles shall be constructed using steel pipe with an O.D. of 10-3/4 inches and a minimum wall thickness of 0.188 inch.

Steel pipe shall be new steel pipe conforming to the requirements for Grade II of ASTM "Tentative Specifications for Welded and Seamless Steel Pipe Piles," Designation A-252. The Contractor shall furnish to the Engineer, written certification from the pipe manufacturer that the pipe supplied meets the requirements of such ASTM Specifications. The welded end plate shall be watertight with a diameter not more than 1/4" larger than the pipe shell.

Each length of pipe shall be legibly marked with the manufacturer's identifying symbol, together with size, weight, length, wall thickness, and the words "Grade 2 Piling" as required in the ASTM Specifications.

415.03 CONCRETE.—Concrete for steel pipe piles shall be Class "A", as set forth in Section 900.11.

The concrete shall be vibrated in the length of the pipe.

Reinforcement for concrete shall be in accordance with Section 421.05.

**415.04 SPLICING.**—The Contractor shall determine the component lengths of pipe for the piles. His attention is directed, however, to required minimum tip elevations and the allowable number of splice connections.

Steel pipes may be spliced before or during driving operations. Each splice connection shall be made by a continuous butt weld in accordance with the requirements of Section 906. The pipe sections shall be properly aligned so that the longitudinal axis of each completed pile will be in a straight line.

The number of splice connections in any pile shall not exceed 3, unless otherwise specified or permitted by the Engineer.

**415.05 PAYMENT.**—Concrete-filled steel pipe piles satisfactorily furnished and constructed complete, in place, as specified, except for driving which will be paid for as set forth in Section 411, will be paid for at the price bid per linear foot.

The quantity to be paid for will be the aggregate length of concrete-filled steel pipe piles measured in place along the longitudinal centerlines thereof between tip and cutoff.

## Section 416

### Furnish and Construct Concrete-Filled Steel Shell Piles

**416.01 GENERAL.**—The Contractor shall furnish and construct concrete-filled steel shell piles where and as shown on the plans or where directed, including, steel shells, splices, concrete, and reinforcing steel, and all other related Incidental Work, all in accordance with the requirements specified herein.

The Contractor shall drive steel shells in accordance with Section 411. Each steel shell shall be driven to the required bearing value before being filled with concrete.

After being driven, and prior to the placing of reinforcing steel and concrete, each steel shell shall be examined for damage or reduced diameter at any point. Any shell improperly driven or broken, or which shows partial collapse to an extent as to materially decrease its bearing value will be rejected as unsatisfactory. Rejected shells shall be removed and replaced, or a new shell driven adjacent thereto. Rejected shells which cannot be removed shall be filled with concrete by the Contractor at his expense.

Driven shells shall be free of water before reinforcing steel and concrete are placed.

The Contractor shall have available at all times a suitable light for inspecting the entire length of each shell before placing reinforcing steel and concrete.

416.02 STEEL SHELLS.--Steel shells shall be of sufficient strength and rigidity to permit driving, and to prevent distortion caused by soil pressures or the driving of adjacent piles, until filled with concrete. The shells shall also be sufficiently watertight to exclude water.

The shells may be cylindrical or tapered, step-tapered, or a combination of either, with cylindrical sections. The tip diameter shall not be less than 8 inches and the butt diameter shall not be less than 12 inches.

Shells to be driven without a mandrel shall be equipped with heavy steel driving tips, and all splices in the shell shall be continuously welded to develop the full strength of the section.

416.03 CONCRETE.--Concrete for steel shell piles shall be Class "A," as set forth in Section 900.11.

The bottom of each shell shall be filled with mortar to a depth of not less than 2 feet immediately before placing the concrete. The mortar shall consist of one part Portlant Cement to 3 parts fine aggregate mixed to a suitable consistency, or Class "A" Concrete with the 3/4 inch and larger aggregate removed.

The concrete shall be vibrated for the length of the shell.

Reinforcement for concrete shall be in accordance with Section 421.05

416.04 PAYMENT.--Concrete-filled steel shell piles satisfactorily furnished and constructed complete, in place, as specified, except for driving which will be paid for as set forth in Section 411, will be paid for at the price bid per linear foot.

The quantity to be paid for will be the aggregate length of concrete filled steel shell piles measured in place along the longitudinal centerlines thereof between tip and cutoff.

No payment will be made for an unsatisfactory pile.

## Section 417

### Furnish Precast Concrete Piles

417.01 GENERAL.—The Contractor shall furnish precast concrete piles of the lengths ordered by the Engineer, or specified, including handling, storing, and doing all other related Incidental Work, all in accordance with the requirements specified herein.

Precast concrete piles shall be constructed of Class "A" Portland Cement Concrete in accordance with the requirements of Sections 900.11, 421 and 422, as applicable.

Concrete for precast concrete piles shall be placed in smooth mortar-tight forms, so supported as to prevent appreciable deformation or settlement during placing or curing. When removed from the form, the pile shall present true, smooth even surfaces free from honeycombs and voids and shall be so straight that a line stretched from butt to tip on any face will not be more than 1 inch from the face of the pile at any point.

Concrete piles, both conventionally reinforced and prestressed, shall be cured as provided in Section 900.16.

Reinforcing steel shall be in accordance with Section 421.05 and prestressing steel in accordance with Section 422.03.

When raising or transporting precast concrete piles, the Contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete. Piles materially damaged in handling or driving shall be replaced by the Contractor at his expense. Concrete piles shall be handled at all times so as to avoid breaking or chipping the edges.

417.02 PAYMENT.—Precast concrete piles, as specified, satisfactorily furnished at the site will be paid for at the price bid per linear foot.

## Section 418

### Concrete Piles Cast in Drilled Holes

418.01 GENERAL. --The Contractor shall construct concrete piles cast in drilled holes where and as shown on the plans, or where directed, including drilling holes, installing casing,, furnishing and placing steel reinforcement and concrete, and doing all other related Incidental Work, all in accordance with the requirements specified herein.

418.02 DRILLED HOLES. --Holes for cast concrete piles shall be drilled so that the maximum deviation of the longitudinal axis at any point from the axis specified shall not be more than one percent of the length of the hole.

All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed before placement of concrete therein.

The use of water for drilling operations or for any other purpose where it may enter the hole will not be permitted. Surface water shall not be permitted to enter the hole and all water which may have infiltrated into the hole shall be removed before placement of concrete therein.

418.03 CASING. --The Contractor, where necessary for the construction of the piles, or the safety of workmen, shall furnish and drive casing in the drilled holes, and shall subsequently withdraw from the holes, and remove, such casing from the site as his property.

Casing shall be removed from the hole as concrete is placed therein. The bottom of the casing shall be maintained not more than 5 feet, nor less than one foot, below the top of the concrete during withdrawal and placing operations.

Should it be necessary to leave sections of casing in place in drilled holes, such sections of casing shall become the property of the City at no cost to the City.

418.04 CONCRETE. --Concrete shall be Class "A" as set forth in Section 900.11.

The concrete shall be vibrated for the length of the pile.

The reinforcing cage shall be placed and secured symmetrically about the axis of the pile and shall clear the sides of the hole.

The Contractor shall place the reinforcing steel and concrete within 24 hours after completion of each uncased pile hole.

Steel reinforcement shall be in accordance with Section 421.05.

418.05 PAYMENT. --Concrete piles cast in drilled holes satisfactorily constructed complete, in place, as specified, will be paid for at the price bid per linear foot.

The quantity to be paid for will be the aggregate length of concrete piles cast in drilled holes measured in place along the longitudinal axis from the lower limit to cutoff.

## **Section 419**

### **Furnish Steel H-Beam Piles**

419.01 GENERAL.--The Contractor shall furnish steel H-beam piles, as required, including splices, steel plate caps, and all other related Incidental Work, all in accordance with the requirements specified herein.

The Contractor shall drive piles in accordance with Section 411.

419.02 H-BEAMS.--H-beams shall be of structural steel conforming to ASTM "Tentative Specifications for Steel Bridges and Buildings," Designation A 7, except that steel manufactured by the acid-bessemer process shall not be used. If approved by the Engineer manufactured welded sections may be used.

419.03 SPLICES.--The length of a steel H-beam pile may consist of spliced sections. The sections shall be of identical cross sections and may be spliced before or during driving operations. Splice connections shall be made by full butt welding the entire cross section in accordance with the requirements of Section 906. The sections shall be properly aligned so that the longitudinal axis of each completed pile will be a straight line. The number of splice connections in the length of a pile shall not exceed 2 unless otherwise permitted by the Engineer.

419.04 CUTOFF.--Piles shall be accurately cut off and capped with a steel plate as shown on the plans. Piles not accurately cut off shall be extended, or provided with an approved equivalent construction, all at the sole expense of the Contractor.

419.05 PAYMENT.--Steel H-beam piles satisfactorily furnished complete, in place, as specified, except for driving which will be paid for as set forth in Section 411, will be paid for at the price bid per linear foot.

The quantity to be paid for will be the aggregate length of steel H-beam piles measured in place along the longitudinal centerlines thereof between tip and cutoff.

## Section 420

### Metal Driving Shoe for Piles

420.01 GENERAL.—The Contractor shall furnish and install metal driving shoes, where and as specified or shown on the plans, or where directed, including all related Incidental Work, all in accordance with the requirements specified herein.

Piles equipped with metal driving shoes shall be driven to rock. The pile shall penetrate the rock 18 inches and driving shall terminate with a blow count of not less than 10 blows per inch. However, if the required blow count is reached before the penetration has been attained, the Contractor shall thereafter continue driving until 120 blows into such rock have been delivered to the pile or until the required penetration has been reached, whichever occurs first.

420.02 PAYMENT.—Metal driving shoe satisfactorily furnished and installed complete, in place, as specified, will be paid for at the unit price bid therefor.

## Section 421

### Concrete Structures

421.01 GENERAL.—The Contractor shall construct plain and reinforced concrete structures, including constructing falsework and formwork, and removal thereof, furnishing and placing reinforcing steel, furnishing, mixing, placing, protecting and curing concrete, surface finishing waterproofing, and all other necessary, or required, Incidental Work, all where and as shown on the plans and in accordance with the requirements specified herein.

421.02 CONCRETE.—Concrete and related materials and work, including mixing, placing, protecting, and curing, shall be in accordance with Section 900. The classes of concrete and the uses thereof are set forth in Section 900.11.

421.03 FALSEWORK.—The Contractor shall furnish, in accordance with the requirements of Section 106.08, to the Engineer for his approval, plans of falsework to be used for the work. The design of the falsework shall provide for the overhead clearances and traffic lane widths necessary to comply with the specified traffic routing requirements. Approval by the Engineer shall not be construed as relieving the Contractor of full responsibility for the accuracy of dimensions and strength and safety of the falsework during construction. If required in the Special Provisions, the Contractor shall engage a registered civil engineer to prepare the plans, and supervise the instal-

lation, of the falsework.

Removal of falsework shall be in accordance with the applicable requirements of Section 421.09.

All falsework materials shall be completely removed upon completion of the work, and all debris and refuse resulting from the work shall be removed and the premises left in a neat and presentable condition.

#### 421.04 FORMWORK

General.—Forms shall be constructed of sound material, mortar tight, and shall be of the correct shape and dimensions. Formwork shall be braced and tied together, sufficiently and in such manner as to prevent movement or displacement occasioned by any phase of the construction operations. In addition, formwork shall be designed for easy removal.

Form supports shall be placed on adequate foundations and shall have sufficient strength and bracing to prevent settlement or distortion from anticipated loading. Supports shall rest on double wedge shims, or other approved devices so that the forms will be maintained at the proper grade.

Forms shall be constructed of 5/8-inch thick minimum, 5 ply, Douglas fir exterior-type concrete form plywood, suitably coated with paraffin oil or plastic, or of steel or other approved material that will be as rigid and provide a surface at least as smooth as the plywood. Joints in form materials shall be located as directed, so that the resulting marks in the concrete conform to the general lines of the structure. Plywood shall be used in full sheets not less than 4 feet by 8 feet in size except where shape and size of the form prevents the use of a full sheet, or where the plywood is retained in a fabricated metal frame or patent form.

Fillets and chamfers shall conform to the size and design shown on the plans or specified in the Special Provisions.

Curved surfaces shall be formed with metal, plywood, or adequately supported, surfaced and match Douglas fir boards not more than 4 inches wide.

Form marks shall not be readily discernible and the number thereof shall be kept to a practicable minimum.

Handrails, balustrades and similar small or intricate structures, or parts thereof, shall be formed with metal, or clear lumber providing an impervious approved non-staining surface. The workmanship of the lumber forms for such work shall be the equivalent of first-class pattern work.

Openings shall be located at the bottom of forms where necessary to facilitate the clearing out of sawdust, wood scraps and debris and to provide drainage. Such openings shall be closed with watertight and secure cover pieces prior to placing concrete. In addition, inspection holes, and covers therefor, shall be provided in the formwork where directed.

Coating and Watering of Forms.—Forms shall be coated with an approved form oil and shall be thoroughly soaked with water before placing concrete.

Form Ties.—Bolts, rods or other approved form ties shall be of sufficient strength and used in sufficient quantities to prevent spreading of the forms. The ties shall be such that they can be entirely removed, or broken back at least  $1\frac{1}{2}$  inches from the finished surface of the concrete. Form ties shall be Superior Concrete Accessories, Inc., "Wood Cone Snap Ties," or approved equal. The use of ties consisting of twisted wire loops will not be permitted.

On surfaces of concrete to remain exposed, the edges of the holes shall not be damaged in removing the cones.

Form ties shall be arranged so that after the forms are removed, the filled holes will be in neat horizontal and vertical patterns.

After the forms have been removed, the holes shall be filled with mortar and finished flush with the surface of the concrete as specified in Section 421.10.

Plumbing, Leveling, Repairing and Maintaining Forms.—Before concrete is placed in any form, the horizontal and vertical position, or the line and grade, as the case may be, of the form shall be carefully verified and all inaccuracies corrected. All wedging and bracing shall be completed in advance of the placing of concrete. All formwork must be approved by the Engineer before any concrete is placed therein.

Forms that have been damaged, or that have checked or warped prior to placing of concrete, shall be replaced or corrected in an approved manner.

The Contractor shall assign a sufficient number of men to maintain the forms and reinforcement, and to satisfactorily remedy any displacement or looseness thereof occurring during the placing of concrete.

#### 421.05 REINFORCING STEEL

General.—Reinforcing steel bars, welded steel wire fabric, and all required appurtenances, shall be furnished and installed where and as shown on the plans and in accordance with the requirements specified herein.

Reinforcing steel bars, numbers 2 to 11, inclusive, shall be in accordance with ASTM "Standard Specifications for Billet-Steel Bars for Concrete Reinforcement," Designation A 15, and ASTM "Standard Specifications for Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement," Designation A 305.

Reinforcing steel bars, except No. 2 bars, shall be deformed, and all bars shall be open hearth steel of the intermediate grade.

Spiral reinforcement may be fabricated from plain intermediate grade bars conforming to ASTM Designation A 15.

Sampling.—Reinforcing steel may be sampled by the Engineer either at the source of supply or at the work, or both. If sampled at the source of supply, the Contractor shall notify the Engineer in sufficient time to permit sampling and testing before shipment is made. Each bundle of steel shall be tagged at the mill with an identifying mill tag showing the name of the mill and the melt or heat number. This tag shall be a metal tag attached with a lead seal and placed in an exposed position for easy identification by the Engineer.

A certified mill copy of mill tests on each heat showing physical and chemical analyses shall be furnished to the Engineer. Two (2) or more samples, each 2.5 feet long, may be taken at random from each size in each melt or heat. The Engineer, at all times, shall be provided access to take random samples. All samples shall be furnished by the Contractor at his expense.

In addition to certification, the City may elect to test the samples, at no expense to the Contractor.

No reinforcing steel shall be incorporated in the work until it has been tested, if required, and approved by the Engineer.

Drawings.—Before placing any reinforcing steel, the Contractor shall submit complete lists, in sextuplicate, showing lengths and bending details, to the Engineer for approval. After approval, if required, the Contractor shall furnish the Engineer with six (6) corrected prints of each bending sheet.

No deviation from the approved lists will be permitted, unless by written consent of the Engineer.

Approval by the Engineer shall not be construed as relieving the Contractor from full responsibility for the accuracy of said lists.

No reinforcing steel shall be installed until after such bending sheets have been approved.

Storage.—Reinforcing steel shall be stored in a manner that will prevent rusting, or coating by dirt or other objectionable matter, or loss of identification after bundles are broken. All steel which cannot be properly identified will be rejected, and shall be immediately removed from the work.

Bending and Straightening.—Reinforcing steel bars shall be shop bent. Field bending will not be permitted, except that Number 5 and smaller bars may be bent in the field when allowed by the Engineer.

Bars shall not be damaged in bending or straightening, and bars with kinks or improper bends shall not be used.

The inside radii of bends, excluding stirrups and ties, for Nos. 3, 4 and 5 bars shall each be  $2\frac{1}{2}$ , or more, times the least diameter of the bar; for Nos. 6, 7 and 8 bars, shall each be 3, or more, times the least diameter of the bar; and for Nos. 9, 10 and 11 bars, shall each be 4, or more, times the diameter of the bar.

The inside radii of bends for stirrups and ties shall be not less than one (1) bar diameter.

Cleaning.—Before placing concrete, the reinforcement shall be cleaned of mortar, oil, grease, dirt, loose mill scale, loose rust, and any other coating of a character that would destroy or reduce the bond.

Placing.—Reinforcing bars shall be firmly and securely held in position by wiring with No. 14 or No. 16-gauge black annealed wire at intersections, and by using precast mortar blocks or metal chairs, spacers, metal hangers, supporting wires, and other approved devices of sufficient strength to afford satisfactory support under full load.

Wood supports, and metal supports which extend to the surface of the concrete, shall not be used. However, metal chairs may have plastic dipped feet placed in contact with the form.

Placing bars on layers of fresh concrete as the work progresses, or adjusting bars during the placing of concrete, will not be permitted.

Reinforcing steel adjacent to bottom forms shall be supported on precast mortar blocks of a thickness sufficient to provide the required clearance from the face of the concrete. Distance from the face of vertical forms shall be provided by the use of temporary supports which shall be removed as the concrete is placed and rising in the forms.

Minimum clear protective covering for reinforcement adjacent to concrete surfaces shall be as set forth in the following table:

#### CLEAR CONCRETE PROTECTIVE COVERING FOR REINFORCEMENT

<u>Member</u>	<u>Types of Exposure</u>	<u>Minimum Clear Covering</u>
Footings, Principal Members, Drilled Cast-In-Place Concrete Piles	Concrete surfaces deposited against ground	3"
Principal Members, Precast Concrete Piles	Concrete surfaces, all or a part of which may be exposed to sea water	2½"
Principal Members	Formed concrete surfaces exposed to ground or weather	2" for #6, or larger bars; 1½" for #5, or smaller, bars
Precast Concrete Piles	Concrete surfaces not exposed to sea water	2"
Columns, Walls, Slabs	Concrete surfaces in contact with sewage	2"
Column Ties or Spirals	All exposures	1½"
Walls	Interior exposures	1½"
Stirrups	All exposures	1½"
Slabs	Exposed to weather or traffic	1½" for #6, or larger, bars; 1¼" for #5, or smaller, bars
Slabs	Not exposed to weather	1½" for #6, or larger, bars; ¾" for #5, or smaller, bars

The minimum clear bar spacing shall be as follows:

<u>Sizes of Bars</u>	<u>Minimum Clear Spacing Between Parallel Bars</u>	<u>Minimum Clear Spacing Between Layers of Bars</u>
#2 to #8, incl.	1"	1"
#9 to #11, incl.	Diameter of Bar	1"

In no case shall these dimensions be less than  $1\frac{1}{2}$  times the maximum size of the coarse aggregate.

Bars in upper layers shall be placed directly above bars in lower layers.

Splicing.—Splices of the main reinforcement shall be located where shown, and at points of minimum stress.

Splicing shall be accomplished by placing the bars in contact with each other and wiring together in such manner as to maintain the required clear distance to the other bars and to the surface of the concrete.

Splicing of reinforcing bars shall be in accordance with the "Building Code Requirements for Reinforced Concrete," ACI 318 of the American Concrete Institute.

In no case shall any splice be less than 24 nominal bar diameters, or 12 inches, in length.

Inspection.—No concrete shall be deposited until the Engineer has inspected the reinforcement and given permission to place concrete.

Steel Wire Fabric.—Steel wire fabric for concrete and gunite reinforcement shall be fabricated from steel wire and electrically welded at all joints and points of intersection, all in accordance with the requirements of ASTM "Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement, Designation A 185.

The wire used in the manufacture of welded wire fabric shall conform to ASTM "Standard Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement, Designation A 82.

Where fabric is used as reinforcement for gunite on flat surfaces such as walls and slabs, it shall be 4" x 4", #6 x #6 welded steel wire fabric. Splices shall be lapped not less than two (2) meshes.

Where fabric is bent around members for protection, repair or reinforcing thereof by guniting, it shall be 2" x 2", #12 x #12 welded steel wire fabric. Splices shall be lapped not less than two (2) meshes.

Where fabric is used as reinforcement for concrete pavement slabs, it shall be 6" x 6", #6 x #6 welded steel wire fabric. The fabric shall be held firmly in place to prevent any vertical or transverse displacement. Splices shall be lapped not less than two (2) meshes.

#### 421.06 EXPANSION JOINTS AND FILLER

Expansion Joints.—All walls, steps, copings, and other concrete structures extending above the ground shall have expansion joints placed not more than sixty (60) feet apart. Expansion joints shall also be placed at the junctions of steps with other structures, and at the top and bottom of any flight of steps.

Joints shall be made with expansion joint filler, 1/4 inch in thickness, in accordance with the requirements specified hereinafter.

The edges of concrete, at the joints, shall be edger finished.

Expansion Joint Filler.—Expansion joint filler shall consist of preformed strips of a durable, resilient, nonextruding compound.

Preformed joint filler material shall be in accordance with the requirements of ASTM "Standard Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Types)," Designation D 1751, or ASTM "Standard Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Nonbituminous Types)," Designation D 1752, as designated in the Special Provisions or most suitable for the purpose intended. The filler, further, shall meet the requirements of ASTM "Standard Methods of Testing Preformed Expansion Joint Fillers for Concrete (Nonextruding and Resilient Types)," Designation D 545.

Where stiffness is lacking in preformed expansion joint filler, the strips shall be encased in saturated felt, asphalt-impregnated cotton webbing, or other satisfactory material. Any material or fabric used for encasement shall be firmly sealed to the body of the joint filler and shall not become detached therefrom after immersion in water for a period of forty-eight (48) hours.

If 10 percent or more of any lot or shipment of expansion joint filler is of nonuniform or improper construction, the entire lot or shipment may be rejected.

Expansion joint filler shall be installed so that it will not be displaced when concrete is deposited against it. Where it is necessary to use more than one piece of filler to cover any surface, the abutting pieces shall be placed in close contact, and the joint shall be covered with a layer of 2-ply roofing felt adhered with hot asphalt to insure proper retention. Any concrete or mortar that has filled the void spaces where expansion joint sealant is to be placed shall be neatly cut and removed.

Expansion Joint Sealant.—Expansion joints shall be sealed with expansion joint sealant when specified in the Special Provision.

The sealant shall be mixed and placed strictly in accordance with the manufacturer's directions and to the depth of joint shown on the plans.

Concrete surfaces against which the sealant is placed shall be thoroughly cleaned by wire brushing and shall be dry. The concrete surfaces shall then be given a prime coat of the primer specified, or that recommended by the manufacturer. The primer shall be worked into the concrete.

The primer shall be allowed to dry tack-free before application of the sealant.

Liquid sealant placed in vertical joints shall be retained with forms lined with polyethylene film.

The joint sealant shall, in all cases, be installed flush with the concrete surfaces on either side of the joint.

**421.07 WATERSTOPS.**—Waterstops shall be furnished and installed where and in accordance with the details shown on the plans and specified herein.

Waterstops, unless otherwise specified, shall be natural rubber, synthetic rubber, or polyvinyl chloride (PVC), at the option of the Contractor.

Natural rubber waterstops shall be manufactured from stock containing not less than 72 percent by volume of new plantation rubber. When tested in accordance with ASTM "Standard Method of Tension Testing of Vulcanized Rubber," Designation D 412, the tensile strength shall not be less than 3,500 pounds per square inch with an elongation at breaking of 550 percent. The unit stresses producing 300 percent and 500 percent elongation shall be not less than 1,100 pounds and 2,800 pounds per square inch, respectively. When tested in accordance with ASTM "Standard Method of Test for Indentation of Rubber by Means of a Durometer," Designation D 676, the Shore durometer indication (hardness) shall be between 55 and 65. When tested in accordance with ASTM "Standard Method of Test for Accelerated Aging of Vulcanized Rubber by the Oxygen-Pressure Method," Designation D 572, and after seven (7) days in air at 158 degrees Fahrenheit ( $\pm 2^{\circ}\text{F.}$ ), or after forty-eight (48) hours in oxygen at 158 degrees Fahrenheit ( $\pm 2^{\circ}\text{F.}$ ) and 300 pounds per square inch pressure, the tensile strength and elongation shall not be less than 65 percent of the original.

Synthetic rubber waterstops shall be manufactured from a compound containing not less than 70 percent by volume of neoprene or GRS. When tested in accordance with ASTM Designation D 412, the tensile strength shall be not less than 2,500 pounds per square inch with an elongation at breaking of 425 percent. When tested in accordance with ASTM Designation D 676, the Shore durometer indication (hardness) shall be between 50 and 70. When tested in accordance with the test method of ASTM Designation D 572, and after seven (7) days in air at 158 degrees Fahrenheit ( $\pm 2^{\circ}\text{F.}$ ), or after forty-eight (48) hours in oxygen at 158 degrees Fahrenheit ( $\pm 2^{\circ}\text{F.}$ ) and 300 pounds per square inch pressure, the tensile strength shall be not less than 65 percent of the original.

Polyvinyl chloride waterstops shall be manufactured from polyvinyl chloride conforming to the Corps of Engineers Specification Number CRD-C572. A certificate shall be furnished with the test sample supplied stating that the sample complies with all of the performance requirements specified under paragraph 6 of said Specification.

Waterstops shall be manufactured with an integral cross-section which shall be uniform within plus or minus 1/8 inch in width, and the web thickness or bulb diameter, within plus 1/16 inch and minus 1/32 inch. The number of splices shall be kept to a minimum. Strips and special connection pieces shall be well cured in a manner such that

any cross section shall be dense, homogeneous and free from all porosity. All junctions in the special connection pieces shall be full molded. During the vulcanizing period, the joint shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross section.

Field splices for either natural or synthetic rubber waterstops shall be vulcanized, or mechanical using stainless steel parts, or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a full-sized tensile strength of 100 pounds times the width in inches.

Field splices for polyvinyl chloride waterstops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's directions. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt, but not char, the plastic.

Waterstops shall, when being installed, be cut and spliced at changes in direction as may be necessary to avoid buckling or distortion of the web or flange.

421.08 ELASTOMERIC BEARING PADS. —Elastomeric bearing pads shall be made of neoprene, cast in molds under pressure and heat, and shall have the properties listed hereinafter, as determined by ASTM "Standard Methods of Sample Preparation for Physical Testing of Rubber Products," Designation D 15:

- 1) Tensile strength, ASTM Designation D 412 . 2, 500 psi minimum
- 2) Elongation at break, ASTM Designation  
D 412 ..... 350 minimum
- 3) Compression set, ASTM Designation D 395,  
Method "B", 22 hours at 158 degrees  
Fahrenheit ..... 25% maximum
- 4) Tear strength, ASTM Designation D 624,  
Die "C" ..... 275 lbs. per inch  
of thickness,  
minimum
- 5) Durometer hardness, Shore "A", ASTM  
Designation D 676 ..... 55  $\pm$  3
- 6) Change in durometer hardness, ASTM  
Designation D 573, heat aged, 70  
hours at 212 degrees Fahrenheit ..... + 10 points,  
maximum

In addition to these requirements, the material shall show no checking when subjected to an exposure of 100 hours in an atmosphere containing  $100 \pm 20$  parts of ozone per 100,000,000 parts of air to conform with ASTM "Standard Method of Test for Accelerated Ozone Cracking of Vulcanized Rubber," Designation D 1149.

Elastomeric bearing pads shall be of the thickness, width and length indicated on the plans. The pads shall be neatly punched to receive dowels where necessary or indicated.

The Contractor shall furnish the Engineer a certification by the manufacturer that the elastomer in the elastomeric bearing pads to be furnished conforms to all of the requirements specified hereinbefore. The certification shall be supported by a certified copy of the results of tests performed by the manufacturer upon samples of the elastomer to be used in the pads, covering all of the hereinbefore mentioned requirements.

**421.09 REMOVAL OF FORMS.**—Side forms for footings, foundations, slabs on grade, or other components that do not resist bending shall not be removed in less than forty-eight (48) hours after pouring of concrete. At times of low temperature or other adverse weather conditions, the Engineer may increase the required time to five (5) days.

The falsework and forms supporting concrete girders, beams, joists, slabs, or other members subject to bending stress, shall not be removed or released in less than fourteen (14) days after the concrete has been placed, or if the members are constructed of Type III (high-early strength) Portland cement, in less than seven (7) days after the concrete has been placed. The addition of one-half sack of cement per cubic yard of concrete will be considered a satisfactory substitute for Type III Portland cement. In any case, the falsework and forms supporting the members shall not be removed until the concrete has attained a compressive strength of at least 2,000 pounds per square inch.

The removal of forms for sewers and sewer structures shall be in accordance with the requirements of Section 309.05, unless otherwise specified in the Special Provisions.

#### **421.10 SURFACE FINISHES OF CONCRETE STRUCTURES**

**General.**—The surface finishes of concrete structures shall be in accordance with the requirements of this Section and shall be of the class or type specified in the Special Provisions.

The surfaces of concrete, unless otherwise specified, shall be given Ordinary Surface Finish in accordance with the requirements specified hereinafter, except that such surfaces, or portions thereof, covered by backfill in the completed work need not be "sacked."

**Ordinary Surface Finish.**—Immediately after the forms have been removed, the Contractor shall remove all form bolts or ties to a depth of at least  $1\frac{1}{2}$  inches below the surface of the concrete. All holes and depressions caused by the removal or setting back of the form bolts or ties shall be cleaned out. All fins caused by form

joints, and other objectionable projections, shall be removed, except in cases where they are buried or otherwise not visible in the completed structure and do not interfere with the designed function of the structure. All rock pockets shall be chipped back and cleaned out. All depressions caused by the removal of form bolts, tie rods, rock pockets or other imperfections shall be filled with Class "B" mortar containing no more water than that necessary for complete hydration. Care shall be exercised to obtain a perfect bond with the concrete, and to obtain the same color in the mortar as in the surrounding concrete. In areas visible in the completed work, cement shall be used in sufficient quantity to obtain the required color. While the mortar filling is still "green", it shall be wiped smooth or have the form grain imprinted in it. Steel finishing tools will not be permitted. At the same time, all surfaces shall be "sacked" by wiping with a folded hemp sack on which a sufficient amount of mortar has been placed to substantially fill the small holes that commonly appear in concrete surfaces.

Class 1 Surface Finish.--After the completion of Ordinary Surface Finish, all surfaces shall be thoroughly rubbed with coarse carborundum stones and all unsightly bulges or depressions, caused by form marks or other imperfections, shall be removed so that a smooth surface of uniform texture and appearance is obtained. A mechanical finisher may be used for this purpose, in which case not less than four (4) days shall elapse between the time the concrete is poured and the finishing started. If the surface is rubbed by hand, a period of not less than two (2) days will be required.

After the hereinbefore referred to process has been completed, the surface shall be washed with water to remove stains and free particles which adhere to the surface after rubbing.

Class 2 Surface Finish.--Where Class 2 Surface Finish is specified, Ordinary Surface Finish and Class 1 Surface Finish shall be completed in succession. A thin cement mortar, consisting of one (1) part Portland cement and one (1) part fine sand, all of which will pass a No. 20 sieve, to which has been added two (2) pounds of calcium chloride per sack of cement, shall then be brushed on the surface. When the cement film has set so that the sand particles or cement will not drag out of the surface pinholes, but before final set has taken place, the entire surface shall be rubbed thoroughly with fine carborundum stones, Nos. 25 to 30, until a smooth, even surface of uniform texture is obtained. No greater amount of mortar shall be applied in advance of rubbing than can be completely rubbed before final setting takes place. Immediately after the rubbing process, the finished surface shall be thoroughly washed with water.

This finish shall be deferred until all other work which would in any way mar or affect the final finish is completed.

Exposed Aggregate Finish.--Exposed aggregate finish, when specified, shall be obtained by using "Control-Set", as manufactured by the Conrad Sovig Company, San Francisco, or approved equal, retardant. Methods and details of application shall conform to the manufacturer's directions.

In areas to receive exposed aggregate finish, wall forms, including their abutting edges, shall be coated with two (2) coats of "Control-Set" prior to pouring. Such forms shall be stripped two (2) days after pouring, unless otherwise directed by the Engineer. The surface of the concrete shall be washed and rinsed using a stiff brush, and if necessary shall be sandblasted to remove the mortar film surrounding the aggregate to a minimum depth of 1/8 inch.

Walkway Finish for Pedestrian Overpasses and Ramps.--Walkway surfaces on overpass and ramp structures shall be floated to a true and dense finish with a wood float or power floating machine, followed by steel troweling after the concrete has hardened sufficiently to prevent excess fine material from working to the surface. The finish shall be brought to a smooth surface free from defects and blemishes. No dry cement, or mixture of dry cement and sand, shall be sprinkled on the surface of the concrete to absorb moisture or to stiffen the mix.

The concrete wearing surface shall be given a final finish by brooming lightly, in a direction transverse to the path of travel, with a fine hair broom to produce a uniform nonskid surface.

421.11 WATERPROOFING OF CONCRETE STRUCTURES.--All surfaces of concrete structures specified on the plans or in the Special Provisions to be waterproofed, and all back surfaces of concrete abutment walls, wing walls and retaining walls, shall be waterproofed with at least two (2) coats of approved emulsified asphalt, allowing adequate drying time between coats, unless some other waterproofing procedure has been stipulated.

Structure and wall surfaces shall be clean and dry and weather conditions suitable, as approved by the Engineer, with an air temperature of not less than 50 degrees Fahrenheit, at the time of applying the emulsified asphalt coatings.

421.12 DRAINAGE FOR RELIEF OF HYDROSTATIC HEAD BEHIND WALLS AND UNDER CONCRETE ON GRADE.--When shown on the plans or specified in the Special Provisions, the Contractor shall construct adequate drains and appurtenances behind walls and under concrete on grade. Unless otherwise specified, pipe to carry such drainage shall be perforated vitrified clay pipe of adequate size, but not less than 6 inches in diameter.

Such perforated vitrified clay pipe shall be "extra strength", of the bell-and-spigot type, and in accordance with the applicable requirements of ASTM "Standard Specifications for Standard and Extra Strength Perforated Clay Pipe," Designation C 211, except that the minimum thickness of the barrel of the pipe shall conform to the Regional Western Standard of the Clay Pipe Institute. Perforated vitrified clay pipe shall be installed with tight-closed joints, but without any mortar or other joining material. The pipe shall be sloped as shown on the plans and each piece of pipe shall be placed, with the perforations facing downward, on a 3-inch deep minimum bed of pervious material.

The section of pervious material to be placed around drains shall be as shown on the plans or specified in the Special Provisions, and when not shown or specified shall be at least 3 inches thick all around the pipe.

Placement of pervious material and the backfill thereover shall be as specified in Section 409.03.

421.13 PAYMENT.—Concrete structures, satisfactorily constructed as specified, each will be paid for at the lump sum price bid therefor.

Any concrete structure for which the Proposal does not contain provision for payment shall be constructed as Incidental Work.

## **Section 422**

### **Prestressed Concrete Construction**

422.01 GENERAL.—The Contractor shall construct prestressed concrete structures and structural components, where and as shown on the plans or where directed, and shall do all related Incidental Work. Unless otherwise specified, prestressing may be done by either pretensioning or post-tensioning. Equipment, methods, and operations shall be in accordance with these specifications, with what is considered generally acceptable for prestressing construction, and with the applicable requirements of the Building Code, Part II, Chapter I of the San Francisco Municipal Code.

Prior to starting prestressed construction, the Contractor shall submit to the Engineer for approval, in accordance with Sections 106.08 and 107.03, complete details of the methods, material and equipment he proposes to use. Any proposed deviations during construction must likewise be submitted. Such details shall outline the method of prestressing, and shall include the amount and arrangement of the prestressing steel in the members, the quantity and arrangement of the mild steel reinforcement in anchorage areas in the members, the proposed locations of bar couplers, if used, anchoring stresses, sequence of stressing prestressing steel, sequence of cutting or releasing prestressing steel, type of post-tensioning enclosures, and specifications and details of anchoring devices, distribution plate or assemblies if required, and pressure-grouting materials and equipment for post-tensioning, together with complete drawings of the forms proposed for casting the member.

Approval on the part of the Engineer of any proposed method, materials, or equipment shall not be construed of relieving the Contractor, in any respect, of full responsibility for successfully completing prestressing operations in accordance with the specified requirements.

Longitudinal steel, prestressed by the post-tensioning or pretensioning method, shall maintain the path of the center of gravity of prestressing force as shown on the plans.

Suitable horizontal and vertical spacers shall be provided as required to hold the wires in place in true position in the enclosures.

Deflection devices shall be removed, after transfer of the prestressing force, to a depth of 1/2-inch below the surface of the unit and grouted flush therewith.

The prestressing strands shall be deflected in such a manner that they are not damaged or distorted and so that there is no appreciable variation in tension over the length of the strand due to frictional losses at the yokes.

Precast units shall be stored, transported and placed so that they will not be overstressed or damaged.

Units shall be listed using suitable approved lifting devices located at points which will produce minimum deflection during installation. Lifting devices shall be removed 1½ inches below the surface of the concrete and the resulting holes filled with an approved expansive grout after units are installed in place.

Post-tensioned precast members shall not be moved until at least 24 hours after pressure-grouting of enclosures. Prestressed members shall not be lifted by attachment at any point more than 3 feet from the ends or points of final support of such members. Prestressed members shall be lifted in the same position with regard to top and bottom faces as that of the final installation of the members and shall be handled so that there will be no sideways, tipping, or racking.

The minimum clear steel cover in prestressed units shall be as follows:

Pretension strands . . . . .	1½ inches
Post-tension ducts . . . . .	1½ inches

The minimum horizontal or vertical clear spacing between pretensioning steel elements at ends of members shall be 3 times the diameter of the steel, or 1-1/3 times the maximum size of the coarse aggregate, whichever is greater.

Where pretensioning steel is harped or deflected, strands may be grouped together at midspan with 3 strands in a vertical row or 2 strands in a horizontal row. The minimum clear distance between groups shall be 1-1/8 inches for 3/8-inch strands, and 1-1/2 inches for 7/16-inch strands.

The strands shall be separated at the ends to provide minimum spacing between strands as indicated above which shall be maintained for a minimum distance of 3 feet at each end of the member.

**422.02 CONCRETE.**—Concrete and related work for prestressed concrete construction shall be in accordance with the following specifications and the applicable requirements of Sections 421 and 900.

The maximum size of aggregate used in prestressed concrete

shall be 1 inch.

Cement used in prestressed concrete construction shall be either Type I or Type II Portland cement at the option of the Contractor. The Contractor shall not however, for the purpose of producing increased strength at an early date, increase the amount of cement from that specified, unless such increase has been specifically approved by the Engineer.

Type III (high-early strength) Portland cement, or calcium chloride as an admixture, shall not be used in the construction of any prestressed concrete structure, nor shall calcium chloride be used in the construction of any concrete member of any other structure in contact with the prestressed steel reinforcement.

Unless otherwise specified, prestressed concrete shall have a minimum strength of not less than 5,000 psi at 28 days, as determined from breaks of test cylinders made and cured under laboratory conditions in accordance with the requirements of ASTM "Standard Method of Test for Compressive Strength of Molded Concrete Cylinders," Designation C 39.

The Contractor shall be responsible for furnishing satisfactory materials for the manufacture of the concrete, proportioned to contain not less than 7 sacks of cement per cubic yard of concrete with the maximum net water content not to exceed 5 gallons per sack of cement, that will produce a workable concrete complying with the foregoing requirements for strength. Additional cement, if required, to produce concrete of the specified strength shall be furnished by the Contractor at his expense.

Five sets of test cylinders, consisting of 2 cylinders per set, shall be taken during the concreting operations from each day's pour, but not less than 5 sets from each 50 cubic yards of concrete poured, in accordance with Section 106.13. One-half the number of cylinders shall be stored for laboratory curing and testing. The remainder of the cylinders shall be cured at the site under conditions of curing identical to those of the proto-type structure.

Compression tests shall be taken at 3, 7, 14 and 28 days for the purpose of ascertaining when tensioning of post-tensioned prestressing steel or release of pretensioning steel may be commenced.

Concrete shall be fully vibrated and consolidated. Approved external vibrators shall be used for the consolidation of concrete inaccessible for adequate internal vibration in the prestressed members. The forms shall be designed and constructed to provide the necessary rigidity to resist displacement or damage as a result of such external vibration.

Concrete shall be cured by a water sprinkling system in accordance with the requirements of Section 900.16 or by an approved steam-curing method. Impervious membrane curing will not be allowed.

All steam-curing operations, including temperatures and length of curing period, shall be submitted for the approval of the Engineer.

Attention shall be given to the prevention of shrinkage or settlement cracks due to rate or sequence of pouring. If shrinkage cracks

appear during the curing process for post-tensioning the Contractor, at no extra cost to the City, shall partially prestress the girder, as directed by the Engineer.

#### 422.03 PRESTRESSING STEEL

General.—Prestressing steel shall be high-tensile, stress-relieved wire strand conforming to the specifications of ASTM "Tentative Specifications for Uncoated Seven-Wire Stress Relieved Strand for Prestressed Concrete," Designation A 416; or high-tensile, stress-relieved wire conforming to the specifications of ASTM "Tentative Specifications for Uncoated Stress-Relieved Wire for Prestressed Concrete," Designation A 421; or high-tensile alloy bars in accordance with these specifications. Grouting, if required, shall be completed immediately after prestressing. All steel shall be satisfactorily protected against corrosion and abrasion during shipping and handling. In post-tensioned members, wire or wire strand shall not be installed prior to steam-curing.

All damaged prestressing steel will be rejected.

All prestressing steel shall be satisfactorily protected from rust or other corrosion prior to use, and shall be free of dirt, rust, grease or other deleterious substances when tensioned.

Working force and working stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, creep of steel, losses in post-tensioned prestressing steel due to sequence of stressing, friction and take-up of anchorages, and all other losses, including those peculiar to the method or system to be used, have taken place or have been compensated for.

The loss of stress in pretensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, and elastic compression of concrete shall be assumed to be 35,000 psi.

The loss in stress in post-tensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, and sequence of stressing, shall be assumed to be 25,000 psi, or more, depending upon the method, system and type of prestressing steel, enclosures and anchorages to be used, and curvature of the steel.

The average working stress in the prestressing steel shall not exceed 60 percent of the ultimate tensile strength of the wire, strand, or bar furnished, or 80 percent of the yield point strength, whichever is smaller.

The prestressing steel shall be anchored at stresses that will result in the ultimate retention of working forces not less than those shown on the plans for members to be prestressed, but in no case shall the prestressing steel be tensioned to a stress greater than 70 percent of ultimate tensile strength of the wire, strand, or bar as furnished.

Overstressing for a short period of time to 75 percent of ultimate tensile strength may be permitted upon the approval of the Engineer, provided the stress after seating of anchorages does not exceed 70 percent of ultimate tensile strength.

Tensioning of post-tensioned prestressing steel or release of pre-tensioning steel shall not be commenced until tests on concrete cylinders, the manufacture and curing of which were the same and under the same conditions as those for the members to be prestressed, indicate the concrete of the members has attained a compressive strength of at least 4,000 psi, unless otherwise specified. Elements shall be cut or released in such sequence as to produce the least eccentricity of stress in the member.

Bars.—Bars furnished shall have an ultimate tensile strength of not less than 145,000 psi and an elongation at rupture of not less than 4 percent in 20 diameters. All bars shall be factory-certified that they have been proof-stressed to at least 90 percent of the minimum ultimate tensile stress specified. Diameter tolerance shall conform to ASTM "Tentative Specification for General Requirements for Hot-Rolled and Cold-Finished Carbon and Alloy Steel Bars," Designation A 29. The modulus of elasticity at 70 percent of the minimum ultimate tensile strength shall not be less than 25,000,000 psi.

The minimum yield strength of prestressing bars at 0.2 of 1-percent permanent strain under the test load shall be not less than 90 percent of the specified ultimate tensile strength. The bars shall have a reduction of area of not less than 15 percent at rupture.

When bars are to be extended by the use of couplers, the assembled units shall produce the minimum guaranteed ultimate strength of the bar. The tests shall be conducted in accordance with California State Testing Laboratory Test Method No. Calif. 641, and the latest revisions thereof, and as further specified under "Testing Prestressing Steel and Anchorage Assemblies," Section 422.07. The failure of any one sample to meet the above requirement shall be cause for rejection of the heat of bars and lot of couplers. Location of the couplers in the member shall be subject to approval of the Engineer. Not more than one coupler will be allowed per assembled unit, unless otherwise specified.

Wires and Strands.—The minimum yield strength of prestressing wire at one percent elongation under the test load shall be not less than 80 percent of the minimum tensile strength set forth in ASTM A 421

Prestressing wire, and wire used in fabricating prestressing strand, shall have a minimum reduction in cross-sectional area of 30 percent at rupture.

The minimum yield strength of the prestressing wire strand at one percent elongation under the test load shall be not less than 85 percent of the minimum breaking strength set forth in ASTM A 416.

All wire strand shall have a modulus of elasticity of not less than 24,000,000 psi at 70 percent of the manufacturer's minimum guaranteed ultimate strength.

If a post-tensioning system requiring heading of the wires is used, the heads shall be formed symmetrically about the axes of the wires and shall be free from seams, fractures and other flaws. No heading process shall be used that causes indentations in the wire. All wire with indentations shall be rejected.

Wire and strands shall be stress-relieved. All strands shall be stress-relieved as a unit after the wires have been formed into a strand.

Wires to be used shall be straightened, if necessary, to produce equal stress in all wires of wire groups, or parallel lay cables, that are to be stressed simultaneously to ensure proper positioning in the enclosures.

**422.04 ENCLOSURES FOR PRESTRESSED STEEL.**—Either enclosures or openings, for the installation of prestressing steel, shall be provided at locations approved by the Engineer. Enclosures, if provided, shall be metallic and mortar tight. If the Contractor elects to form openings in lieu of installing enclosures, the forms shall be cores or ducts composed of rubber or other suitable material that can be removed prior to the installation of the prestressing steel.

All enclosures or openings shall be provided with pipes or other suitable connections for the injection of grout after the prestressing operations have been completed.

All enclosures, cores, or ducts shall be accurately positioned and firmly secured in position to prevent displacement during concrete placing operations.

The minimum inside diameter of enclosures shall be  $\frac{1}{4}$  inch larger than the diameter of the prestressing steel.

All enclosures or openings shall be pressure-grouted after prestressing has been completed. The grout shall completely fill the enclosures or openings. The grouting equipment shall be capable of grouting to a pressure of at least 100 psi. The grout, unless otherwise permitted by the Engineer, shall have the consistency of heavy paint, and shall consist of one part Portland cement and one part clean sand passing a No. 30 Sieve, or of neat cement and water, at the option of the Contractor. No admixture will be permitted in the grout. When permitted to stand until setting takes place, the grout shall neither bleed nor segregate.

Enclosures or openings shall be clean and free of all foreign materials that would impair bonding of the grout. Each enclosure or opening shall be thoroughly cleaned out by washing, followed by blowing out by air immediately prior to grouting.

Ducts must be provided with entrance and discharge ports which can be readily closed.

Grout must be applied continuously until it flows steadily from the discharge port, indicating removal of trapped air and water. The discharge port shall then be closed and grouting pressure maintained for the length of time necessary to insure complete filling of the void. The entrance port shall then be closed.

If the enclosures and prestressing steel for post-tensioning are cast in place, no tensioning will be permitted until it is demonstrated, to the satisfaction of the Engineer, that the prestressing steel is free and unbonded in the enclosure. Evidence that the steel is unbonded will be considered satisfactory if longitudinal movement of the steel observed at one end of the enclosure is accom-

panied by a similar movement of such steel at the other end, or when an auxiliary mild steel wire, placed in the enclosure for the full length of the enclosure can be pulled intact from the enclosure.

Grouting post-tensioning ducts shall be done immediately following completion of prestressing.

422.05 DISTRIBUTION PLATES AND ANCHORAGES FOR POST-TENSIONED PRESTRESSING STEEL. --All post-tensioned prestressing steel shall be secured at the ends by means of approved anchoring devices which shall be of such nature that they will not kink, neck down, or otherwise damage the prestressing steel.

Anchorage devices shall be capable of holding the prestressing steel without slip of more than 1/8 inch at a load producing the ultimate stress in the prestressing steel.

Distribution plates, consisting of welded steel or cast steel bearing assemblies for the support and distribution of the load from the anchorage devices, shall be furnished and installed except as hereinafter provided.

Distribution and bearing assemblies designed by the Contractor shall be in accordance with the following requirements:

- 1) The unit compressive stress in the concrete underneath the plate or assembly, assuming uniform pressure distribution, shall not exceed 3,000 psi; and
- 2) Bending stresses, in the plates, or assemblies, induced by the pull of the prestressing steel, as calculated by a rational design method, shall not exceed 30,000 psi. In addition, there shall be no visible distortion, as determined by the Engineer, in the plates or assemblies when the maximum prestressing load is applied.

If the bearing area of any anchorage device is sufficiently large so that a local concentrated bearing compressive stress in the concrete is not more than that specified above, the steel bearing assemblies may be omitted.

A sample of the proposed anchorage device shall be submitted for testing.

422.06 PRESTRESSING. --All prestressing steel shall be stressed by means of hydraulic jacks, each equipped with an accurate reading, calibrated, hydraulic pressure gauge for stress computations. Each jack and its gauge shall be accompanied by a certified calibration chart showing the relationship between gauge readings and the tension in the piston rod when (a) a controlled force is applied against the jack, and (b) the jack is applying force. Tensioning shall be done from both ends of the work, unless otherwise specified.

Pressure gauges shall be of sufficient size that they may be accurately read, and the smallest unit of calibration shall not be larger than one percent of the maximum pressure required under the approved tensioning procedure.

Prestressing force shall be determined by measuring elongation of the prestressing steel and checking jack pressure on a calibrated gauge. When there is a difference of over 5 percent between the

steel stress determined from elongation and from the gauge reading, the tensioning operation shall cease until the cause of the discrepancy is ascertained.

The estimated loss in stress, as submitted by the Contractor, for post-tensioned prestressing steel due to friction between the steel and the enclosure during stressing, shall be substantiated by approved friction tests during tensioning of the first unit cast and subsequent units, as necessary. Testing procedures shall require jacking from both ends of the cables in stages up to the specified initial stress. All labor, materials, equipment and tools required for the friction tests shall be furnished by the Contractor at no cost to the City. If the estimated friction losses are exceeded, the prestressing method shall be revised to take into account the greater stress losses found.

More than one unit may be pretensioned in one operation and cast in a continuous line.

#### 422.07 TESTING PRESTRESSING STEEL AND ANCHORAGE ASSEMBLIES

General.--The City will designate a recognized testing laboratory to which the Contractor shall deliver, for testing, the necessary samples from each lot of prestressing steel and anchorage assemblies to be used in the work. Lengths of samples, practicable for testing, shall be as required by such laboratory.

All testing in the laboratory will be done at City expense and at no cost to the Contractor.

All wire, strand or bar of each size, from each mill heat to be shipped to the site, shall be assigned an individual lot number and shall be tagged in such manner that each such lot can be accurately identified at the job site. Each lot of anchorage assemblies and bar couplers to be installed at the site shall be likewise identified. All unidentified prestressing steel, anchorage assemblies or bar couplers received at the site will be rejected.

Samples from each size and each heat of prestressing steel and each lot of post-tensioning anchorage assemblies and bar couplers to be used in the work shall be furnished to the laboratory for testing as follows:

Wire--Sufficient length to make up at least 3 parallel lay cables of the length required for proper testing, consisting of the same number of wires required for the cable to be furnished. Wires requiring heading for anchoring shall be cut to length and headed on both ends;

Bars--Not less than three lengths, cut from separate bars, with anchorage units attached, and complete with the distribution plates, or assemblies required. If bars are to be used with couplers, 6 lengths shall be assembled with couplers into 3 units;

Strand--At least 3 samples of each lot of strand to be furnished with each size of strand assigned an individual lot number.

Each wire or strand sample shall be cut from separate spools. For post-tensioning strand, samples shall be furnished with anchor-

age units attached and complete with any distribution plates or assemblies required.

In addition, the Contractor shall furnish at least 2 post-tensioning anchorage assemblies, complete with distribution plates, of each size or type to be furnished, if anchorage assemblies are required and are not attached to reinforcement samples.

All samples submitted shall be accompanied by a written certification from the Contractor that the samples were taken from, and are representative of, each lot to be furnished.

All of the above material specified to be furnished for testing shall be furnished to the laboratory free of cost to the City, and it shall be the Contractor's responsibility to make certain that such materials shall be furnished well in advance of the desired time of use in order that there will be ample time for testing and no delay in the work.

422.08 GROUTED KEYWAYS AND CONNECTIONS. --Keyways and connections shall be grouted with Class "C" mortar in accordance with the following specifications and the applicable requirements of Section 900.09. The water/cement ratio by weight shall be between 0.30 and 0.35. The consistency shall be such that, upon squeezing a portion of the mortar in the hand, the mortar will form a hard ball without oozing through the fingers or showing surplus moisture on the outside.

The mortar shall be placed in the joint in layers not to exceed 3 inches in thickness. Each layer shall be firmly tamped before the next layer is placed.

No equipment or other loads will be allowed until the grout in keyways and connections has attained a compressive strength of 3,000 psi.

422.09 INSPECTION AND TESTING OF PRECAST UNITS AT OFF-SITE PLANT. --If precast units are fabricated at off-site plants, the Contractor shall furnish the Engineer, or his designated representative, ready access to such plant at all times work on the units is in progress, and shall provide suitable facilities for inspecting and testing tensioning, casting, and curing operations, including the taking and storage of concrete test cylinders.

The Contractor shall notify the Engineer, in writing, at least four (4) weeks in advance of the approximate date of start of fabrication of the units, and subsequently shall notify the Engineer three (3) days in advance of the specific date for start of fabrication.

422.10 STAGING AND FALSEWORK. --Staging and falsework shall be in accordance with the requirements of Section 421.03.

422.11 REMOVAL OF FORMS AND FALSEWORK. --Removal of forms and falsework shall be in accordance with the requirements of Section 421.09.

422.12 PAYMENT. --Prestressed concrete construction shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 423

### Gunite

423.01 GENERAL.—The Contractor shall construct gunite where and as shown on the plans, or where directed, including furnishing guniting equipment, preparing the surface to be gunited, furnishing and installing reinforcement, coloring, placing, finishing, curing, and doing all other related Incidental Work; all in accordance with the requirements set forth herein.

Gunite shall not be placed during freezing or other adverse weather conditions unless approved protective measures are taken.

Only experienced foremen, gunmen, nozzle men and rodmen shall be employed and, if requested, the Contractor shall furnish satisfactory written evidence of such experience to the Engineer.

423.02 OPERATING REQUIREMENTS.—Not less than 500 cubic feet of air per minute, (manufacturer's rated compressor capacity) at a minimum pressure of 45 psi in the gun chamber, shall be required for proper gunite placement and adequate "blowout" jet requirements. Water under a pressure of at least 15 psi in excess of air pressure shall also be required. Pressure requirements shall be increased with the height of the operation above the gun and length of hose required.

The cement gun shall be operated with a minimum air pressure of 45 psi in the gun tank when 100 feet or less of hose is used and the pressure should be increased 5 psi for each additional 50 feet of hose required.

423.03 WIRE MESH REINFORCEMENT.—Steel wire mesh reinforcement shall be in accordance with the requirements of Section 421.05.

The wire mesh shall be firmly secured in place so that no vertical or transverse displacement will occur during placement of the gunite.

The wire mesh shall be supported on concrete blocks of a thickness sufficient to provide the required clearances.

423.04 GUNITE.—Gunite shall be a mixture of Portland cement and sand, mixed dry, passed through a cement gun, or other similar device, hydrated at the nozzle and properly shot by air pressure into its final position.

Gunite shall have the proportion of one part Portland cement by volume, to not more than 4 parts loose, dry sand, by volume.

The word "dry" as applied to the sand means that it shall not contain more than 5 percent nor less than 3 percent of moisture.

Sand for gunite shall consist of material of siliceous, granitic or igneous origin, and shall be hard and durable. It shall be free

from oil and injurious amounts of clay, shale, mica or other objectionable materials.

When tested in accordance with the requirements of the ASTM "Method of Test for Amount of Material Finer than No. 200 Sieve in Mineral Aggregates by Washing," Designation C 117, no more than 4 percent by weight shall pass the No. 200 sieve.

When tested in accordance with the requirements of ASTM "Method of Test for Organic Impurities in Sands for Concrete," Designation C 40, sand shall not show a solution color darker than the standard color solution.

The dry sand shall have a particle size distribution such that the percentage composition by weight, determined by test using standard sieves of square mesh wire construction, will conform to the following grading requirements:

<u>Sieve Size or Number</u>	<u>Percent by Weight Passing</u>
3/8" . . . . .	100
No. 4 . . . . .	95-100
No. 16 . . . . .	45- 80
No. 50 . . . . .	10- 30
No. 100 . . . . .	2- 10

No particle shall be larger than 3/8 inch in diameter. The sand shall have a fineness modulus of between 2.50 and 3.30. Any variation in the fineness modulus during the progress of the work greater than 0.20 plus or minus from the initial value of the accepted sand, shall be cause for rejection of the sand for further use.

The cement and dry sand shall be thoroughly mixed for not less than one minute in a dry state in a mechanical mixer, except that, where specifically permitted small quantities shall be mixed by hand. Mixed materials, if not placed within one hour after preparation, or if allowed to become damp, shall be rejected.

Guniting at the age of 7 days shall develop a compressive strength of not less than 3,000 psi, and at 28 days not less than 4,000 psi, unless calcium-aluminate, as specified in Section 423.05, is required.

423.05 CALCIUM-ALUMINATE. --Calcium-aluminate cement shall be used in accordance with the directions of the manufacturer. The amount of calcium-aluminate cement added to the mix shall not exceed 20 percent of the total amount of cement used. The time of initial set shall not be less than 15 minutes nor more than 30 minutes. The 7-day and 28-day strengths of the guniting to which calcium-aluminate cement has been added shall not be less than 1,500 psi and 3,000 psi, respectively.

423.06 COLORING.—When coloring is required, the Contractor, prior to the commencement of work, shall furnish the Engineer samples of the specified color. The Engineer will select the shade. The coloring agent shall be integrally mixed with the gunite in strict accordance with the manufacturer's recommendations. The color and shade of the completed and cured gunite shall be uniform.

423.07 SURFACE PREPARATION.—All bonding surfaces upon which gunite is to be applied shall first be satisfactorily cleaned of dirt, vegetable matter, grease, oil, rust, scales and all other substances that would prevent complete and adequate bond.

Concrete surfaces to be gunited shall be prepared by wire brushing, using high pressure air and water, sandblasting, combinations thereof, or approved equivalent means, to remove all foreign and loose materials.

Earth surfaces to be gunited shall be prepared by removing vegetation, debris, and loose materials; by excavating and constructing embankment, if specified; and by moistening and compacting the area to be gunited in order to form a firm foundation.

423.08 PLACING.—Gunite shall be applied only to those surfaces approved by the Engineer.

Gunite shall not be applied to surfaces upon which there is free water, but the surface shall be sufficiently damp to prevent absorption.

Ground or gaging wires shall be used as alignment guides to establish thicknesses, surface planes and finish lines. The wires shall be located at intervals sufficiently close to assure proper thickness of the gunite throughout, shall each be stretched tight between individual supports, and shall remain undisturbed in place until the finish coat of gunite has been applied.

Expansion joints shall be constructed as shown on the plans. Expansion joint filler shall be in accordance with Section 421.06. The top or outer 1/2 inch of all expansion joints shall be filled with an approved asphalt-latex emulsion joint sealant. Any mortar that has sealed across any expansion joint shall be neatly cut and removed.

Air and water shall be supplied to the gunite placing machine under such pressure as necessary to produce the most satisfactory results. The pressure shall be constant and free from pulsation.

The consistency of the gunite shall be such that there is no tendency for it to flow down the slope or separate while being placed.

In spraying the hydrated mixture on any surface, the nozzle shall generally be held about 3 and not more than 5 feet from the surface. The nozzle shall be held so that the stream will impinge, as nearly as possible, normal to the surface, with the material arriving at the nozzle uniform in stream and texture. Care shall be taken to prevent the occurrence of sand pockets, and if any develop, they shall be immediately cut out and satisfactorily replaced with mortar.

The time interval between successive applications in sloping, ver-

tical or overhanging work must be sufficient to allow initial, but not final, set to develop. At the time the initial set is developing, the surface shall be lightly and carefully broomed to remove all laitance and provide a better bond with succeeding applications.

Construction joints, or the day's work joints, shall be sloped off to a thin, clean, regular edge at a 45 degree slope. Before placing the adjoining work, the sloped edges and the surrounding gunite shall be thoroughly cleaned and wetted with water, following which the free water shall be blown off with an air jet or removed by other approved means.

Materials that have been mixed for more than 45 minutes and have not been incorporated in the work shall not be used, unless permitted by the Engineer.

**423.09 TEST CYLINDERS.**—When required by the Engineer, test cylinders shall be taken representing the quality of gunite placed by each nozzleman. Each cylinder shall be dated, numbered, and the name of the nozzleman noted, together with the part of the structure into which he placed the gunite. Test cylinders shall be made by shooting gunite into a mold of 3/4-inch metal mesh (hardware cloth) to make cylinders 6 inches in diameter and 12 inches long. The excess material outside the mold shall be trimmed off with a sharp-edged trowel. About 24 hours after making the cylinders, the hardware cloth form shall be removed and the cylinders stored for curing and testing in accordance with the requirements of ASTM "Methods of Test for Compressive Strength of Molded Concrete Cylinder," Designation C 39.

**423.10 REBOUND.**—Material which rebounds and does not fall clear of the work shall be blown off and removed from the work in a suitable manner, and shall not be reused. When an air blow-out jet is used to remove rebound, care must be taken to avoid interference with the flow of gunite, or the work of the nozzleman. No rebound material shall be dumped upon streets, into catchbasins, or otherwise into the City sewer system.

**423.11 FINISHING.**—Gunite surface finish shall be "Class 1, Nozzle Finish" unless specified otherwise. Gunite finishes shall be of the following classes:

Class 1, Nozzle, Finish—The gunite shall be brought during application to an even plane and to well-formed corners by working up to ground wires or other thickness or alignment guides.

Class 2, Screeded and Flashcoated Finish—High spots shall be trimmed off and low spots exposed by using a thin edge screed, by working up against gravity and by employing a slicing motion. A thin finishing flash coat shall be applied to remove rough areas after the ground wires have been removed.

Class 3, Float Finish—A Class 1, nozzle finish shall first be attained, then lightly rubbed with a flat burlap or rubber pad with a circular or spiral motion. No hand patching will be allowed.

Class 4, Trowel Finish—A Class 2, screeded and flash coated finish

shall first be attained, then steel troweled to obtain more free smooth surfaces with a minimum of trowel pressure. Troweling shall be done not more than hour after placing the gunite.

**423.12 CURING.**—Gunite lining shall be cured in accordance with the requirements of Section 900.16.

**423.13 PAYMENT.**—Gunite satisfactorily constructed, complete in place, as specified, will be paid for at the price bid per sack of cement incorporated into the completed gunite lining.

Each sack of cement shall contain 94 lbs. of cement, net weight. As the cement sacks are emptied, they shall be neatly bundled into bundles of 50 to facilitate counting by the Engineer.

## Section 424

### Masonry

**424.01 GENERAL.**—The Contractor shall do all masonry work, including all Incidental Work necessary or required, to complete all brickwork, concrete block structures, or other masonry, where and as shown on the plans, or where directed, and in accordance with the requirements specified herein.

Materials, workmanship, and installation shall be in accordance with the applicable requirements of the San Francisco Building Code.

Mortar used for jointing masonry units shall be Class "B" or "C" in accordance with the requirements of Section 900.09. Mortar shall be mixed with the minimum amount of water necessary to secure proper hydration.

**424.02 BRICK.**—Brick shall conform to the requirements of ASTM "Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)" Designation C 62, Grade MW.

**424.03 CONSTRUCTION.**—All masonry work shall be of the highest quality.

Masonry units shall be built plumb and true to lines, with the courses level, and shall be constructed with tight joints. Bricks, blocks, or other units for walls, shall be laid with the vertical joints aligning over the center of the unit below (running bond). All joints shall be approximately 3/8-inch thick and be completely filled with mortar. Masonry units shall be shoved into place; buttering will not be permitted. Excess mortar shall not be struck off in such a manner as to pull the mortar from adjoining unit faces. Joints shall be finished flush.

**424.04 PAYMENT.**—Masonry shall be constructed as Incidental Work and payment therefor shall be included in the price or prices bid.

Section 425

Steel and Other Metal Structures

425.01 GENERAL. --The Contractor shall construct steel and other metal structures and shall do related work where and as shown on the plans and in accordance with the applicable requirements specified herein. Materials, workmanship, fabrication, erection, fireproofing, and design of steel structures and related metalwork shall be in accordance with the applicable requirements of the San Francisco Building Code and the following specifications, as applicable:

- 1) Bridges. --"Standard Specifications for Highway Bridges," of the American Association of State Highway Officials (AASHO), and "Specifications for Steel Railway Bridges," of the American Railway Engineering Association (AREA);
- 2) Buildings and Other Structures. --"Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings," of the American Institute of Steel Construction (AISC); and
- 3) Aluminum Alloy Structures and Metalwork. --"Suggested Specifications for Structures of Aluminum Alloys 6061-T6, 6062-T6, 6063-T5 and 6063-T6," American Society of Civil Engineers (ASCE).

425.02 SHOP DRAWINGS.--The Contractor shall furnish shop drawings, in accordance with the requirements of Section 106.08, for all steel structures and related metalwork.

425.03 MATERIALS. --Unless otherwise specified, materials shall be in accordance with the applicable of the following ASTM Specification Designations:

<u>Materials</u>	<u>ASTM Designations</u>
Structural Steel .....	A 7
Structural Rivet Steel .....	A 141
Arc-Welding Electrodes .....	A 233
Gas Welding Rods .....	A 251
Bolts and Nuts .....	A 307
High Strength Steel Bolts, Nuts and Washers .....	A 325
Carbon Steel Forgings for Pins and Rollers .....	A 235, Class C1
Cold-Finished Carbon Steel for Pins and Rollers .....	A 108
Cast Steel .....	A 27, Grade 65-35
Cast Iron .....	A 48, Class 30
Malleable Iron Castings .....	A 47, Grade 32510

<u>Materials</u>	<u>ASTM Designations</u>
Wrought-Iron Shapes and Bars.....	A 207
Wrought-Iron Pipe .....	A 72
Steel Pipe for Columns and Railings .....	A 53
Light Gauge Steel Sheets .....	A 245
Bronze Castings .....	B 22
<u>Aluminum-Alloys</u>	
Sheet and Plate .....	B 209
Drawn Seamless Tubes .....	B 210
Bars, Rods, and Wire .....	B 211
Extruded Bars, Rods, Shapes, and Tubes .....	B 221
Standard Structural Shapes .....	B 308

425.04 TESTS OF MATERIALS. --Unless the Contractor furnishes certified test results from an accepted testing agency, or mill laboratory, or mill, to prove that the materials are in accordance with the requirements set forth herein, such materials shall be limited to use in minor parts not affecting the strength of the structure.

425.05 STORAGE OF MATERIALS. --Materials to be stored shall be placed above the ground on platforms, skids, or other supports, and shall be kept free from dirt, grease, and other foreign materials and properly drained and protected from corrosion.

Long members, such as columns and chords, shall be uniformly supported on skids sufficient in number to prevent undue deflection.

425.06 BOLTS, NUTS AND WASHERS. --Unless otherwise specified, all bolts, nuts and washers, including anchor bolts, shall be galvanized.

Unless otherwise specified, high strength steel bolts, nuts and washers shall not be galvanized and the method of installation shall be in accordance with the applicable requirements of Section 902.03.

425.07 WELDING. --Welding shall be in accordance with the applicable requirements of Section 906.

425.08 GALVANIZING. --Galvanizing of metalwork shall be in accordance with the applicable requirements of Section 907.

425.09 PAINTING. --Painting of metalwork shall be in accordance with the applicable requirements of Section 909.

425.10 PAYMENT. --Steel structures and related metalwork, satisfactorily constructed as specified, each will be paid for at the lump sum price bid therefor.

Any steel structure or related metalwork for which the Proposal does not contain provision for payment shall be constructed as Incidental Work.

## Section 426

### Timber Structures

426.01 GENERAL.—The Contractor shall construct timber structures where and as shown on the plans and in accordance with the applicable requirements specified herein.

Materials, workmanship, fabrication, erection, fireproofing, and design of timber structures shall be in accordance with the applicable requirements of the San Francisco Building Code and the "National Design Specification for Stress Grade Lumber and its Fastenings" published by the National Lumber Manufacturers' Association, which shall be referred to herein as the National Design Specification.

426.02 SHOP DRAWINGS.—The Contractor shall furnish shop drawings, in accordance with the requirements of Section 106.08, for all timber structures.

#### 426.03 MATERIALS

Structural Framing Members.—All structural framing members of wood shall be Douglas fir construction grade (1500 f), as graded by the West Coast Lumbermen's Association. Other species of wood and grade specified shall be in accordance with the applicable requirements of the National Design Specification.

Treated Wood.—All treated wood shall be pressure-treated with creosote. The pressure treatment with creosote, and other preservatives when specified, shall be in accordance with the applicable requirements of Section 427.

Plywood.—All plywood used in locations exposed to weather shall be Douglas fir plywood C-C Grade, and in all other locations, C-D Grade, in accordance with the applicable requirements of the "Douglas Fir Technical Data Handbook", published by the Douglas Fir Plywood Association.

Glued Laminated Lumber.—Glued laminated lumber shall be in accordance with the applicable requirements of the "Standard Specifications for Structural Glued Laminated Douglas Fir Lumber", as published by the West Coast Lumbermen's Association.

Fasteners for Wooden Members.—Fasteners for wooden members, such as wood connectors, bolts with the required nuts and washers, lag screws, wood screws, spikes, nails, etc., shall be in accordance with the applicable requirements of the National Design Specification. All bolts and lag screws shall be provided with malleable iron or plate washers under heads and nuts. All fasteners shall be galvanized when used in locations exposed to the weather.

426.04 HANDLING AND STORAGE OF WOOD MEMBERS.—Lumber and timber shall be protected by the Contractor from the elements, to the satisfaction of the Engineer, until incorporated into the structure for which it is intended.

Untreated lumber and timber shall be open-stacked at least 12 inches above the ground. Lumber and timber that has been treated with preservative shall be close-stacked and piled to prevent warping.

Lumber and timber shall be piled so that it may be readily inspected, and shall be handled in a manner that will avoid injury or breakage. Treated lumber and timber shall be handled with rope slings. Cant hooks, peaveys, or other sharp instruments shall not be used in handling lumber and timber. Undue injury in handling will be cause for rejection.

Materials exposed to the elements through improper storage or transportation shall be subject to reinspection. Materials failing to meet the original requirements of grade and moisture content in reinspection shall be replaced at the sole expense of the Contractor.

**426.05 FRAMING OF WOOD MEMBERS.** -- All wooden members shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth, and tenons shall fit snugly. No shimming will be permitted when making joints nor will open joints be allowed.

Wooden columns or posts shall be framed to true end bearings. Mud sills shall be firmly and evenly bedded in solid material.

Wooden members shall be connected together in a secure manner so that all forces will be adequately transferred from one member to another.

Holes for drift pins and dowels in untreated lumber and timber shall be bored with a bit 1/16 inch less in diameter than the pin or dowel to be used.

Holes nor drift pins and dowels in treated lumber and timber shall be bored with a bit of the same diameter as the pin or dowel.

Holes for rods shall be bored with a bit 1/16 inch greater than the rod diameter.

The use of bolts and other fastenings for the connection of wooden members shall be in accordance with the applicable requirements of the National Design Specification.

Countersinking shall be done whenever smooth faces are required. Recesses therefor shall be saturated with preservative, when specified, in accordance with the requirements of Section 427.01.

Minimum nailing of different connections shall be in accordance with the San Francisco Building Code.

**426.06 PAYMENT.** -- Timber structures, satisfactorily constructed as specified, each will be paid for at the lump sum price bid therefore, except as otherwise specified in the Special Provisions.

When timber structures are specified to be paid for on the basis of the quantity of lumber and timber incorporated into a structure, measurement will be made in accordance with the applicable requirements of Section 110.04.

Any timber structure for which the Proposal does not contain provision for payment shall be constructed as Incidental Work.

## Section 427

### Wood Preservative Treatment

427.01 GENERAL. --The Contractor shall treat lumber and timber with wood preservative, in accordance with the requirements set forth in the Special Provisions and herein.

Lumber and timber shall be pressure treated except as otherwise specified.

Timber piles required to be treated shall be pressure treated with creosote unless otherwise specified on the plans or in the Special Provisions.

So far as practicable, all cutting, adzing, boring, chamfering, gaining, mortising, surfacing, and the like, shall be done prior to treatment.

All pressure treatment shall be done in accordance with the applicable requirements of Federal Specification TT-W-571, "Wood Preservation; Treating Practices," and other specifications therein included, except as modified herein, on the plans or in the Special Provisions.

Maximum possible penetration shall be obtained with whatever preservative and vehicle is specified and used, and such penetration shall conform to or exceed that outlined as minimum in the hereinbefore referred to Federal Specification. The depth of penetration, measured at right angles to the surface of the wood, shall be determined by means of borings. After testing, the bored holes shall be filled with tight-fitting treated plugs. Test borings in piles shall be made mid-way between the ends.

Treated lumber, timber, and timber piles, the surface of which have been damaged by cutting, gouging, boring, or otherwise, in such manner as to reduce the effectiveness of the treatment, will be rejected unless, in the opinion of the Engineer, the damaged treated areas can be satisfactorily repaired. The repair of damaged areas, when permitted, shall be by saturating or coating with a preservative material furnished by the company that pressure treated that particular lot of wood, in accordance with the recommendations of that company.

Unless permitted by the plans or Special Provisions in the case of small quantities of materials, no creosoted or otherwise treated material from stock will be accepted.

When specifically permitted on the plans or in the Special Provisions, small quantities of untreated wood members may receive on-the-job preservative treatment, after cutting, surfacing, boring and the like, by dipping or brushing with the preservative material specified on the plans or in the Special Provisions. Three (3) saturating coats shall be successively applied to every surface, including borings, with adequate drying time allowed between coats, the last coat being applied after the wood members have been framed in place.

Wood members specified for on-the-job preservative treatment, unless otherwise specified, shall not be incised on the surfaces as set

forth hereinafter. Preservative shall not be applied to wet wood or to wood surfaces on which free moisture is present.

427.02 INSPECTION.—All lumber and timber to be treated shall be in accordance with the applicable requirements of Section 426 and grade marked prior to treatment. Timber piles shall be in accordance with the requirements of Section 412. After treatment, all lumber, timber and timber piles shall be inspected by an inspector from a recognized testing laboratory, or inspection service, approved by the Engineer. Each piece shall be stamped by the inspector with a mark different from that used for grade marking. No preservative treatment inspection stamp will be required for on-the-job dip or brush treatment.

The Contractor shall furnish the City with the official inspection certificate of the laboratory or inspection service.

Treated lumber, timber, and timber piling shall be subject to inspection by the Engineer after arrival at the site or after being placed in the completed structure, and no previous inspection at the plant shall bar rejection in the completed structure.

427.03 HANDLING.—All treated lumber, timber, and timber piles shall be carefully handled with rope slings without sudden dropping, breaking of the outer fibers, bruising, or penetration of the surface. Cant dogs, hooks, pike poles or similar tools shall not be used except in the case of creosoted piles where such tools may be used within 3 feet of either end of the piles.

Treated lumber, timber, and timber piles, the surfaces of which have been damaged in handling, will be rejected or shall be repaired as specified hereinbefore in Section 427.01.

427.04 PREPARATION AND TREATMENT.—Lumber, timber, and timber piles which are to be creosoted or otherwise treated shall be air-seasoned, or seasoned by boiling under a vacuum, until all water which would interfere with the treatment process has been removed.

Before treatment, all sawed lumber and timber 2 inches or more in thickness shall be incised on all 4 sides by means of a suitable power-driven machine with cutting teeth designed to give a uniform penetration and a regular pattern. The spacing of the incisions shall be in accordance with the recommendations of the manufacturer of the preservative, and the depths of the incisions shall not be less than the depths set forth in the following table:

<u>Thickness of Timber</u>	<u>Depth of Incision</u>
6" and over .....	3/4"
3" and under 6" .....	1/2"
2" and under 3" .....	1/4"

427.05 PRESSURE TREATMENT WITH CREOSOTE.—Pressure treatment with creosote shall be in accordance with the requirements of Table I of Federal Specification TT-W-571, and shall be with the creosote-vehicle combination specified, or if not specified, best suited for the material, its condition and intended use. The creosote used shall be in accordance with the requirements of the ASTM "Standard Specifications for Creosote," Designation D 390.

The penetration of creosote in the wood will be determined by the presence of black or dark oil. Light staining due to capillary action will not be considered acceptable penetration.

427.06 PRESSURE TREATMENT WITH PENTACHLOROPHENOL.—Pressure treatment with pentachlorophenol, including the preservative solution used, and the degree of retention and penetration, shall be in accordance with the requirements of Table II of Federal Specification TT-W-571 and other specifications therein included, unless otherwise specified.

Pentachlorophenol shall be used where the treated material will not be in contact with salt water, where the use of creosote would be objectionable, where the surfaces shall be paintable, or where specified on the plans or in the Special Provisions, except that unless otherwise specified it shall not be used for timber piles. Special attention shall be given to the type of petroleum solvent used and the period of seasoning after treatment where the requirements of Section 427.08, the plans, or the Special Provisions require the surface to be paintable.

When pentachlorophenol-liquefied petroleum gas solution is used, the solution, retention, and penetration shall conform to the following requirements:

- 1) The solution shall be made up of: 1) pentachlorophenol conforming to the requirements of Federal Specification TT-W-570 and; 2) volatile petroleum solvents having a distillation end point not greater than 40°F.
- 2) The retention of pentachlorophenol shall not be less than the following:
  - Under five (5) inches thick -  
0.50-pound per cubic foot;
  - Five (5) inches and thicker -  
0.40-pound per cubic foot.
- 3) The penetration in inches or percent of sapwood penetration of pentachlorophenol shall not be less than the following:
  - Under five (5) inches thick -  
3/8 inch penetration or 90 percent of sapwood;
  - Five (5) inches and thicker -  
1/2 inch penetration or 90 percent of sapwood.

427.07 PRESSURE TREATMENT WITH WATER-BORNE PRESERVATIVES.—Pressure treatment with water-borne preservatives, including the preservative solution used, and the degree of retention and penetration, shall be in accordance with the requirements of Table III

of Federal Specification TT-W-571 and other specifications therein included, unless otherwise specified.

Treatment with water-borne preservatives shall be used where specifically permitted on the plans or in the Special Provisions, for moderate leaching conditions where there is no exposure to marine borers, and where wood treated with oil-borne preservatives would not be satisfactory due to odor, color, oily surface or possible unpaintability.

Lumber and timber treated with water-borne preservatives shall be dried to a moisture content that will not interfere with the application or retention of paint.

427.08 ARSENIC AND CREOSOTE PRESERVATIVES PROHIBITED WHERE ACCESSIBLE TO PUBLIC. --Wood treated with solutions containing any form of arsenic, creosote or other agent similarly toxic or otherwise hazardous to persons, livestock or domestic animals, shall not be used in locations accessible to persons, livestock or domestic animals, especially in locations where food or beverages are to be prepared, consumed or stored. Preservatives used in such locations shall be of the type that can be satisfactorily painted over without bleeding, and shall be painted over.

427.09 TREATMENT OF TIMBER PILE HEADS. --The heads of all timber piles shall be treated, after the piles have been driven and cut off to the proper elevation, with 2 applications of a hot mixture of 60-percent creosote oil and 40-percent roofing pitch.

427.10 FIRE RETARDANT TREATED WOOD. --Fire retardant treated wood shall meet the requirements, for the specific use intended, of the Building Code, Part II, Chapter I, of the San Francisco Municipal Code.

427.11 PAYMENT. --Wood preservative treatment, satisfactorily performed, including inspection and handling, shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.



## **PART V**

### **MECHANICAL WORK**

#### **Section 500**

##### **General Requirements**

**500.01 RULES AND REGULATIONS.** --Mechanical work, equipment and materials, including the installation thereof, shall be in full accordance with the requirements of the National Board of Fire Underwriters; the Pacific Fire Rating Bureau; the State Fire Marshal; the Safety Orders issued by the Division of Industrial Safety, Department of Industrial Relations, of the State of California; the San Francisco Fire Department Bureau of Fire Prevention and Public Safety; the Municipal Building and Plumbing and Gas Appliance Codes of the City and County of San Francisco; and any other prevailing codes and regulations pertinent to adequate protective measures and prevention of hazardous conditions.

**500.02 PERMITS.** --The Contractor shall obtain, at his own expense, prior to start of any mechanical work in buildings and in other locations outside of street areas, all necessary permits from the Department of Public Works for the work covered by the specifications, except as such permits may have been previously obtained. Plumbing permits also will be required for landscaping irrigation work, or other plumbing work connecting to City water supply systems, in street areas.

**500.03 ADJUSTMENT OR RELOCATION OF EXISTING FACILITIES.** If required to permit the prosecution of the work, the adjustment or relocation, as approved by the Engineer, of existing electrical conduit and contained wires, existing pipes or existing ducts, where such conduit and pipes are  $1\frac{1}{4}$  inches or less in nominal diameter and the ducts are one square foot or less in cross-sectional area, shall be considered Incidental Work. The adjustment or relocation of larger sized existing facilities, however, unless specifically indicated for such adjustment or relocation on the plans or in the Special Provisions, if necessary as determined by the Engineer, shall be done as directed, as Extra Work in accordance with the requirements of Section 111.

**500.04 FLOOR, WALL AND CEILING OPENINGS.** --The Contractor shall secure the Engineer's approval of the locations for holes and openings in floors, walls and ceilings, necessary for the installation of

mechanical equipment, ducts, piping and appurtenances, and shall keep to a practicable minimum the size of such holes and openings. He shall conduct his operations in such manner as to prevent cracking or otherwise damaging floors, walls and ceilings. He shall close all holes and openings, and repair, in an approved manner, all damage resulting from his operations, leaving no impairment of structural, functional, or architectural quality and shall match the configuration, texture and color of the adjacent existing surfaces. He shall, except as otherwise specified, paint all patched surfaces, with one (1) coat of primer and two (2) coats of finish paint, to match the surrounding area. Painting and preparation therefor shall be in accordance with the applicable requirements of Section 909.

Holes and openings in or through existing concrete or masonry floors, walls and ceilings shall be made by drilling with proper size carboloy-tipped twist drills, diamond drill bits, or diamond core drills. The use of impact drills of any type will be permitted only with the approval of the Engineer.

500.05 UNINSPECTED WORK NOT TO BE CLOSED IN.--The Contractor shall not cover up nor enclose any of his work until it has been tested by him in the presence of the Engineer and until it has been inspected and approved by the Engineer. Should any of the work be enclosed or covered up before such inspection and test, the Contractor shall, at his own expense, uncover the work and, after it has been inspected, tested and approved, restore such covering and enclosure.

500.06 DAMAGE BY LEAKS OR BREAKS.--Damage to any part of the premises of its improvements caused by leaks or breaks in the equipment, piping or appurtenances installed by the Contractor, or caused by leaks or breaks in existing equipment, piping or appurtenances resulting from his operations, shall be considered defects in the work or damage to existing improvements, as the case may be, as set forth in Section 105.10, and as such shall be the responsibility of the Contractor for a period of one (1) year following the date of acceptance of the work in the case of surface improvements.

500.07 WATER METER INSTALLATIONS.--When water meters are required in conjunction with the contract work, the Contractor shall make all necessary arrangements with the San Francisco Water Department for the installation of such meters and, if required, the removal of any existing meters, all at the locations shown on the plans. The installation of each meter, including the service piping thereto, and the connection of such piping to City water mains, will be accomplished by San Francisco Water Department personnel, but all fees and costs therefor shall be solely the responsibility of the Contractor.

For information regarding such fees and costs covering work to be performed by the Water Department, Bidders shall contact the Manager of the Commercial Division, San Francisco Water Department, 425 Mason Street, San Francisco.

Arrangements for installation of water meter service shall be made not less than thirty (30) days prior to the date on which the Contractor intends to make use of the City-furnished water, or not less than thirty (30) days prior to the completion date of the contract, as applicable, in order to allow the San Francisco Water Department sufficient time to complete their work.

**500.08 GAS METER INSTALLATIONS.**--When gas meters are required in conjunction with the contract work, the Contractor shall make all necessary arrangements with the Pacific Gas and Electric Company for the installation of such meters at the locations shown on the plans. The installation of each meter, including the service piping thereto, and the connection of such piping to Pacific Gas and Electric Company gas mains and pressure reducing valve, where required, between the meter and the gas mains, will be accomplished by Pacific Gas and Electric Company personnel, but all fees and costs therefor shall be solely the responsibility of the Contractor.

The application for new service shall be made not less than thirty (30) days prior to the completion date of the contract in order that the Pacific Gas and Electric Company may perform the work within the specified contract period.

## **Section 501 Steelwork**

**501.01 STEEL AND HARDWARE.**--Steel, and the fabrication and installation thereof, shall be in accordance with the applicable requirements of Section 902.

All bolts and nuts shall conform to ASTM "Standard Specification for Low-Carbon Steel Externally and Internally Threaded Fasteners," Designation A 307, Grade "B", and shall be standard machine bolts with cold pressed hexagonal nuts, except as otherwise specified. All bolts and nuts specified to be galvanized shall have a free running fit. Anchor and assembly bolts shall be of ample size and strength for the purpose intended. No existing bolts, nuts, washers, etc., shall be reused in contract work, unless specifically indicated for such reuse on the plans or in the Special Provisions.

### **501.02 WELDING**

**General.**--All welding shall be performed in accordance with the applicable requirements of the latest "Standard Code for Arc and Gas Welding in Building Construction," Serial Designation D1.0, of the American Welding Society, or the latest Specifications for Fusion Welding of the American Institute of Steel Construction, and Section 906 of these Standard Specifications.

Only those welders who are experienced and have passed qualification tests under the AWS "Standard Qualification Procedures" shall be employed and the Contractor may be required to show Certified employment and test records for each welder.

All welding shall be done in the shop before galvanizing, if the latter is required, except as specifically otherwise permitted by the Engineer.

All welding work to be subsequently galvanized shall be thoroughly cleaned and prepared so as not to impair the quality of galvanizing.

Surfaces to be welded shall be cleaned by wire brushing, chipping or hammering away any loose mill scale, rust, paint or other foreign matter present on the metal. The cleaning shall extend at least two inches on each side of the weld, except as otherwise specified. Welds shall be cleaned each time the electrode is changed.

In assembly and during welding, the component parts shall be held by sufficient clamps or other adequate means to keep the parts in their proper positions and in close contact.

Welds shall show uniform sections, smoothness of metal, feather edges without undercuts or overlays and freedom from cracks, porosity or clinkers. Visual inspection of edges and ends of fillets and butt joint welds shall indicate good fusion with and penetration into the base metal. All burrs and lumps of metal shall be removed, leaving a neat and workmanlike appearance.

All weld slag and spatter shall be completely removed before galvanizing or painting.

Any welds or portions of welds found defective, in the opinion of the Engineer, shall be removed and replaced.

Welding of Steel Pipe and Fittings.—All welded joints for steel pipe, attachments and fittings, unless otherwise shown on the plans or specified in the Special Provisions, shall be fusion-welded in accordance with AWS Code for Industrial Piping using suitable welding rods as recommended by the American Welding Society. All joints shall be open, single "V" type with all pipe and fitting ends scarfed on an approved angle to within 1/16 inch of the inside wall of the pipe or fitting. The abutting ends shall be separated and properly spaced and aligned before tacking. All finished welds shall be of sound metal and shall present a neat and workmanlike finish. All welded pipes and fittings shall be subjected to a hydrostatic test pressure not less than that specified in the Special Provisions, followed by a soap-and-water test for leaks. All defects in the welding shall be corrected. All welds that leak or sweat are defective, and shall be cut away. The pipe and/or fittings shall then be resurfaced and new welds made and retested.

501.03 GALVANIZING.—Galvanizing shall be done where shown on the plans or when specified.

Equipment and materials to be galvanized shall be hot-dip galvanized in accordance with the requirements of Section 907.

## Section 502

### Piping, Tubing, Fittings, Valves and Other Appurtenances - Materials and Installation

502.01 GENERAL.--All piping, tubing, fittings, valves and other piping system appurtenances shall be free of defects, and of the make, brand and quality specified, or approved equal. All such piping, tubing and appurtenances shall be installed by the Contractor where and as shown on the plans, or where directed by the Engineer.

The kind and size of pipe, tubing and appurtenances to be used for the particular application shall be as shown on the plans and/or as specified in the Special Provisions.

Workmanship shall be of the highest quality, and installation shall be in accordance with the practices recognized as best by the plumbing trade.

Where sizes or strengths of pipes are omitted from the plans and not set forth in the Special Provisions, the sizes and strengths shall be adequate for the functions to be performed, as determined by the applicable codes and regulations and as approved by the Engineer, unless heavier materials or more stringent requirements are indicated, in which case the indicated sizes will govern.

All piping shall be erected to accurate lines and grades, and where possible, pipes shall be laid horizontally or vertically, and parallel or perpendicular to each other and to building walls, to make a workmanlike installation.

All lines, fittings, valves and appurtenances in buildings or elsewhere shall be located so that they can be easily removed or repaired without disturbing other parts of the lines; shall be adequately stayed, braced and anchored, and shall be installed in a neat and workmanlike manner. Appearance as well as utility shall be given consideration.

All vertical lines in buildings shall be supported by brackets or standard clamps and shall not depend upon resting or hanging from other pipelines or equipment.

Maximum clearance beneath overhead piping in buildings shall be maintained.

Unions shall be provided at all points where necessary to facilitate the assembly of screwed piping.

Fittings required but not shown on the plans shall be furnished and installed by the Contractor at his sole expense to the extent required by Section 103.03.

No hot water line shall parallel a cold water supply line at less than 10-inch center-to-center distance except where necessary in the immediate vicinity of a plumbing fixture being served.

Except as otherwise specified, piping installed in lawn and other planted areas, or under center or traffic island pavement, shall have a minimum of 10 inches of cover; under sidewalk areas, a minimum of 24 inches of cover; and under roadway pavement, a minimum of 30 inches of cover; all measured from the finished ground or pavement grade, as applicable.

## 502.02 STEEL PIPING AND FITTINGS

General.--Where weight or strength of pipe is referred to in the Special Provisions or on the plans by "Schedule Number," such "Schedule Number" refers to Standard B-36.10 as adopted by the American Standards Association. Standard weight pipe is referred to as "Schedule 40" and extra strong pipe is referred to as "Schedule 80."

Steel pipe and fittings used for domestic hot and cold water piping, waste and vent piping, and gasoline piping, shall be galvanized.

Fittings and Flanges.--Screwed fittings for steel pipe, unless otherwise specified, shall be threaded, square band, malleable or cast iron, and cut with full threads. Fittings for steel pipe used for waste lines, unless otherwise specified, shall be of the long sweep pattern, cast iron drainage fittings.

Flanged fittings for steel pipe, unless otherwise specified, shall be 125-pound cast iron, and shall be in accordance with the requirements of ASA Specification B16.1 American Standard dimensions, facing and drilling.

Steel butt-welding fittings shall be in accordance with the requirements of ASA Specification B16.9.

Flanges for steel pipe, unless otherwise specified, shall be forged steel "slip-on" welding flanges, 150-pound standard, welded inside and outside, or forged steel welding neck flanges, 150-pound standard. Where steel flanges are bolted to 125-pound cast iron flanges, the raised faces on the steel flanges shall be removed.

Fittings and flanges shall be as specified on the plans or in the Special Provisions. Only one make of fittings and flanges will be permitted in the "roughing-in" of the piping system.

Making Up Screwed Joints.--Pipe shall be cut square and true, and ends of pipe shall be carefully reamed open to full diameter removing all burrs and sharp edges. Pipes shall be free from tool marks.

Threads on pipe shall be carefully cut with clean dies so that the axes of screwed fittings will coincide with the axes of the pipe to which they are attached.

Threads on stainless steel pipe shall be carefully cut with dies manufactured specifically for cutting threads on stainless steel pipe, and shall be cut in accordance with the pipe manufacturer's recommendations.

Screwed joints, except for gasoline and diesel fuel oil piping and high pressure hydraulic (oil) system piping, shall be made up with graphite, red lead and linseed oil, or approved joint compound.

Pipe make-up dope for gasoline and diesel fuel oil piping shall be a product approved for use in petroleum piping, nonsoluble in gasoline or oil.

Screwed joints for high pressure hydraulic (oil) system piping shall be made up with approved teflon tape thread sealant, suitable for high pressure oil systems.

Screwed fittings shall be run up a minimum of eight full threads. Joint compound shall be applied to the male thread only when assembly is made and all excess compound shall be wiped off all joints. Care shall be taken to keep pipe free from dirt and debris, and compound

shall be applied in such a manner that it will not enter pipe lines. Cord, string, caulking, etc., will not be permitted on threaded piping to make joints tight.

Making Up Flanged Joints. -- Flanged joints shall be made in accordance with the best standard practice.

When making up joints for flanged pipe and fittings, the Contractor shall furnish and install gaskets where necessary, or required.

Gaskets, unless otherwise specified, shall be ring type gaskets at least 1/16-inch thick, and made of the material specified in the Special Provisions. Gaskets for 125-pound cast iron flanged joints, or for steel flanges with faces removed which are bolted to 125-pound cast iron flanges, shall be full face.

Flanges shall be carefully cleaned before being gasketed and bolted.

Flanged joints shall be made up square with even pressure on gaskets and shall be watertight.

Flanged joint bolts shall be standard machine bolts with cold pressed hexagonal nuts, and both shall be galvanized steel.

Flanged joint bolts for pipe submerged in water or sewage shall be of high strength cast iron having a minimum tensile strength of 50,000 pounds per square inch.

### 502.03 BELL AND SPIGOT CAST IRON PIPING AND FITTINGS FOR PLUMBING WORK.

General. -- All cast iron pipe and fittings for sewers, soil lines, wastes, leaders and vents shall conform to the requirements of Commercial Standard CS-188-59, "Cast Iron Soil Pipe and Fittings", and shall be labeled with the "CI" mark illustrated in Commercial Standard CS-188-59, or approved equal.

All underground soil, waste and vent lines shall be of extra heavy weight cast iron soil pipe and fittings.

All cast iron piping for above ground soil lines, wastes, leaders and vents shall be of service weight cast iron soil pipe and fittings.

All cast iron pipe and fittings shall be concentric, sound, free from all defects, and completely coated inside and outside with coal tar pitch, applied hot.

Fittings for cast iron pipe used in plumbing work shall be of the same make, material, and inside diameter as the pipe with which they are used, and shall be of equal quality and weight, coated both inside and outside with coal tar pitch, applied hot.

Lead for joints shall be in accordance with the requirements for Common Desilvered Lead, ASTM "Standard Specifications for Pig Lead," Designation B 29.

Making Up Joints and Installation. -- The Contractor shall make all joints in accordance with the following requirements:

The spigot end of each piece of pipe shall be inserted into the corresponding bell the full depth of the bell and the spigot adjusted in the bell so as to give a uniform space for the joint, which shall be made of first quality oakum and pig lead. The oakum shall be thoroughly and evenly packed into the bell so as to fill it tightly for a depth of one inch

(Allowance shall be made in each joint for not less than one pound of lead for each inch of nominal pipe diameter). The remaining space shall then be filled with pure lead, which has been brought to the proper temperature and cleaned of scum, a bead being left on the outside of the face of the bell sufficient to allow for caulking so that when the joint is properly caulked the lead will be flush with the face of the bell. The use of cold plugs will not be allowed.

In pouring lead, the melting pot shall be kept near the joint to be poured and only one pour shall be made for each joint. The joint shall be perfectly clean and dry when the lead is applied. Dross shall not be allowed to accumulate in the melting pot.

Care shall be taken in making joints to provide suitable escape for the air in the joint when it is being poured.

The joints shall be thoroughly caulked by competent workmen using proper and satisfactory tools, in such a manner as to secure a tight joint without overstressing the iron in the bells. In all cases, the caulking shall be done towards the gate and other points where the lead is likely to be porous, so as to compact it there.

In disconnecting existing pipe and fittings, the joints shall be melted out. The faces of all bells, and six inches of the spigots of all pipe and fittings, shall be thoroughly cleaned of all dirt, scale and other foreign matter before new lead joints are made.

Where pipe is buried underground, trenches shall be excavated so that the barrel of the pipe will have an even bearing along its entire length, and with sufficient clearance provided for any necessary operations in connection with the laying of the pipe. Pipe shall be supported for the entire length, not by the bell ends only, on the required sand bed. Bell holes shall be excavated for each pipe bell or joint and shall be of sufficient size to ensure proper making of joints. Backfilling for the pipe shall be as specified in Section 304.

Where pipes are laid on grades, the pipes shall be installed with the bells upgrade.

#### 502.04 CAST IRON PRESSURE PIPING AND FITTINGS

General.—Pressure type cast iron pipe shall be in accordance with ASA Specification for "Cast Iron Pipe Centrifugally Cast in Metal Molds for Water or Other Liquids", Designation A21.6. Barrel thickness of pipe shall be as specified in the Special Provisions.

Mechanical joints for cast iron pipe shall conform with ASA Specification A21.11.

Tyton joints for cast iron pipe shall be in accordance with Federal Specification WW-P-421B, Section 3.1.2.

Flanged joint pipe, unless otherwise specified, shall be made up by threading plain end pipe, screwing the flanges on, and machine-tightening until the pipe end protrudes past the face of the flange. The pipe end and the flange shall then be faced giving a flush surface across the end of the pipe and the face of the flange.

Flanges shall be faced and drilled in accordance with ASA Specification B16.1 for Class 125 and ASA Specification B16.2 for Class 250.

Fittings.--Fittings for mechanical and Tyton joint pipe shall be short-body, cast iron fittings in accordance with ASA Specification A21.10 and joints therefor shall be mechanical joints conforming to ASA Specification A21.11.

Fittings for cast iron flanged pipe shall be cast iron flanged fittings in accordance with ASA Specification B16.1 for Class 125 and B16.2 for Class 250.

Cement Lining.--Cast iron pipe and fittings, unless otherwise specified, shall be cement lined in accordance with ASA Specification for "Cement Mortar Lining for Cast Iron Pipe and Fittings", Designation A21.4, except for the thickness requirement, which shall be 1/16-inch minimum.

502.05 WELDED WROUGHT IRON PIPE.--Welded wrought iron pipe shall be in accordance with the requirements of ASTM "Standard Specifications for Welded Wrought-Iron Pipe," Designation A 72.

Welded wrought iron pipe shall be black or galvanized, as specified in the Special Provisions, and of the dimensions and weights specified therein. Each length of pipe shall be legibly marked to show the name or trademark of the manufacturer. All pipe two inches or more in diameter shall be lap-welded.

Wrought iron is defined in ASTM "Standard Definitions of Terms Relating to Wrought Iron," Designation A 81, as a ferrous material, aggregated from a solidifying mass of pasty particles of highly refined metallic iron with which, without subsequent fusion, is incorporated a minutely and uniformly distributed quantity of slag.

The Contractor shall certify in writing that the pipe installed is of wrought iron in accordance with the requirements of ASTM Designation A 72.

#### 502.06 COPPER TUBING AND FITTINGS

General.--Copper tubing, unless otherwise specified, shall be Type "K" for underground and Type "L" for above ground, hard temper tubing, and shall conform to ASTM "Standard Specifications for Seamless Copper Water Tube," Designation B 88. Soft temper tubing shall be used, when specified on the plans or in the Special Provisions, or where directed by the Engineer, for cases where flexibility or a minimum of joints are desired or in the case of limited access. No bends shall be made in copper tubing except by use of preformed fittings or with tools insuring smooth bends without kinks.

Fittings.--Fittings for copper tubing shall be of the sweated-type, wrought copper, solder-joint type, fabricated in accordance with ASA B16.22 and meeting ASTM "Standard Specifications for Seamless Copper Tube," Designation B 75.

Unions shall be the ground joint type and of copper or bronze. Long screw or other similar packed joints will not be permitted.

Elbows, tees and other fittings installed in the vicinity of plumbing fixtures shall be of the drop-ear or flanged type and shall be securely anchored to a suitable backing or to the building framework, as directed by the Engineer, so as to permit no pipe movement at the fixtures.

Dielectric type unions, connectors or couplings shall be used at all connections of copper tubing to ferrous metal piping and equipment, unless otherwise specified in the Special Provisions.

All fittings shall be sweated except at connections to equipment and valves where screwed, flared, or flanged fittings shall be used or as otherwise specified. All valves shall be bronze and shall have IPS screwed connections or solder type connections.

**Making up Joints.**—Copper tubing shall be cut with a tubing cutter or hacksaw, full length with square ends, and shall be fully reamed with a tubing reamer and sandpapered clean before soldering. Cutters designed for steel pipe shall not be used. After cutting, the tubing shall be sized with a sizing tool, if required.

Joints shall be made either with 95-5 tin-antimony or 95-5 lead-tin solder, ASTM "Standard Specifications for Solder Metal," Designation B 32, Grade 5A, unless otherwise specified. Joints shall be made with torches designed for the purpose; the use of blow torches will not be permitted.

Copper-to-copper joints for condensate return tubing and other tubing to be used for carrying high temperature fluids shall be made by brazing with phosphor-bearing 15-percent silver solder. If copper-to-ferrous metal soldered joints are specifically called for in tubing for carrying high temperature fluids, such joints shall be made with 35 to 50-percent silver, phosphor-free solder and an appropriate flux. Extreme care and enough welding tips shall be used to prevent overheating of silver brazed joints. Any joints showing evidence of overheating shall be removed and replaced at the Contractor's expense. Finished silver brazed joints shall show a fillet of bright silver alloy completely around the edge of the joint.

**Fastening of Tubing.**—Copper tubing shall be fastened to buildings or structures at six-foot intervals to prevent excess noise and vibration, shall be braced to prevent excess swaying, and shall be separated from steel at hangers, straps, etc., with three thicknesses of dielectric tape, except in cases where hangers are of a special copper-plated type.

#### 502.07 HYDRAULIC FLUID LINE TUBING AND FITTINGS

**General.**—Hydraulic (oil) line tubing shall be of cold-drawn seamless low carbon steel, annealed for bending and flaring. The interior of the tubing shall be bright and clean and free from grease-drawing compounds, oxide, scale, carbon deposits and any contamination not readily removed by alkaline cleaners or benzine. Tubing shall be of the sizes shown on the plans, and where the maximum working pressure does not exceed 1,000 p.s.i.g. and the hydraulic fluid temperature does not exceed 155°F., shall have wall thicknesses in accordance with the following schedule:

<u>Tubing Size</u> <u>Outside Diameter (Inches)</u>	<u>Wall Thickness</u>	
	<u>Gauge</u>	<u>Inches</u>
1/4	20	0.035
3/8	20	0.035
1/2	18	0.049
5/8	16	0.065
3/4	16	0.065
7/8	13	0.095
1	13	0.095

Tubing fittings shall be flare type steel fittings, having an angle of 37° with the tubing center-line (74° included angle) and shall be 3-piece having a sleeve between the nut and the tubing.

Tubing and fittings shall conform to the specifications and recommended practice of the Joint Industry Conference (JIC) "Hydraulic Standards for Industrial Equipment."

Minimum Bend Radii.--When installing tubing, the minimum bend radius of tubing bends shall be as shown in the following schedule:

<u>Tubing Size</u> <u>Outside Diameter (Inches)</u>	<u>Minimum Radius to</u> <u>Tubing Center Line (Inches)</u>
1/4	9/16
3/8	15/16
1/2	1-1/2
5/8	2-1/4
3/4	3
7/8	3-1/2
1	4

Tubing shall be free of kinks and flat spots causing an area reduction of more than 20 percent.

Making Up Joints.—When making joints, the burrs shall be removed from the inside of the tubing end and the flare carefully made so that there are no cracks or flaws in the surface coming in contact with the fitting.

When tubing is used for high pressure hydraulic (oil) systems, screwed joints to equipment, cylinders, valves, etc., shall be made up with approved teflon tape thread sealant, suitable for high pressure oil systems.

Fastening of Tubing.—Tubing shall be supported securely with Super Strut, or approved equal, channels and O.D. tubing pipe clamps, hot-dip galvanized after fabrication. Supports shall be spaced in accordance with the following schedule:

<u>Tubing Size</u> <u>Outside Diameter (Inches)</u>	<u>Distance</u> <u>Between Supports (Feet)</u>
1/4, 5/16, 3/8, 1/2.	4
5/8, 3/4, 7/8, 1.	5

Cleaning of Lines.--After final assembly, but before making final connections to equipment, and before final tests, all tubing lines shall be cleaned by washing with alkaline solution or benzine.

502.08 PIPING, TUBING, AND FITTINGS OF OTHER MATERIALS, CLASSES AND TYPES.--The piping, tubing, and fittings specified hereinbefore in Sections 502.02 through 502.07, inclusive, are of those materials, classes and types used most frequently in Bureau of Engineering mechanical construction, replacement and reconstruction, and maintenance and repair jobs. Not precluded is the use of piping, tubing, and fittings as otherwise may be specified in the Special Provisions, including, but not limited to, the following:

- Alloy steel pipe and fittings;
- Seamless stainless steel tubing and flared-tube fittings;
- High silicon iron alloy pipe and fittings, bell and spigot type, extra heavy weight, of "Duriron," "Corrosiron," or approved equal;
- Red brass pipe and fittings;
- Asbestos-cement pressure pipe and fittings;
- Polyvinyl chloride (PVC) and other plastic pipe and fittings;
- Vitrified clay pipe and fittings.

502.09 VALVES.--Valves shall be installed with the stems vertically up, but may, if necessary and approved by the Engineer, be installed with stems in a horizontal position.

Gate valves shall be used where the service requires valves to be either wide open or shut tight.

Globe and angle valves shall be installed so that the pressure is under the disc and shall be placed where and as shown on the plans or where throttling is required.

All valves shall be of the same size as the piping to which they are connected, unless otherwise specified on the plans or in the Special Provisions.

All valves shall be as specified on the plans or in the Special Provisions, or their approved equal. Only valves of one manufacturer shall be furnished and installed, if possible.

No valves, existing in piping to be replaced under any contract, shall be reused or relocated unless specifically designated on the plans or in the Special Provisions for such reuse or relocation.

502.10 INSULATION OF PIPING AND APPURTENANCES.--Unless otherwise specified herein or in the Special Provisions, piping and tubing, required to be insulated, shall be covered with 85-percent magnesia asbestos sectional or segmental covering with eight-ounce canvas jacket tightly stretched, neatly pasted on, and securely held in place by

two (2) metal bands for each three-foot section. Thickness of insulation shall be as specified on the plans or in the Special Provisions. After the insulation has dried thoroughly, it shall be sized, in place, with an approved lagging adhesive, with anti-mold for ratproofing.

Fittings, valve bodies, stub ends and similar parts, except unions and flanges, unless otherwise specified, shall be covered with 85-percent magnesia asbestos plastic cement built up to the same thickness as the adjacent pipe covering and then covered with eight-ounce canvas jacket securely held in place and lapped to the canvas of the adjacent pipe insulation. The insulation shall be sized, in place, as set forth hereinbefore.

Unless otherwise specified in the Special Provisions, hot water piping and tubing, however, required to be insulated, shall be covered with an approved fiber glass sectional covering, with standard factory attached canvas pasted smoothly over the insulation, and each three-foot section additionally secured with at least two metal bands. Thickness of insulation shall be as specified on the plans or in the Special Provisions. All fittings and other appurtenances, except unions, unless otherwise specified, shall be covered as set forth hereinbefore or with an approved insulating cement equal to the thickness of the adjoining pipe covering and finished with canvas. All canvas shall be additionally finished with one heavy brush coat of an approved lagging adhesive.

Pipe insulation at hanger and support locations shall be fitted with steel protection saddles.

Any existing insulation damaged during the course of the work shall be replaced.

Piping and appurtenances shall not be insulated until after installation, inspection, testing and approval. Pipe shall be clean and dry prior to application of insulation.

Piping normally requiring insulation includes, but is not limited to, steam supply lines, exposed condensate return lines within six feet of floors, and hot water lines.

#### 502.11 PIPING IDENTIFICATION AND COLOR CODE.

General.—Piping furnished and installed in new buildings and pipe tunnels shall be identified and the direction of flow indicated by means of approved colored, pressure sensitive, self-adhesive markers, as specified herein. Piping furnished and installed in existing buildings and pipe tunnels shall be labeled similarly only when specifically called for on the plans or in the Special Provisions. The markers shall be applied after all cleaning and painting of the piping and insulation is completed.

The identification shall be applied to all piping, except for that piping which is located in furred spaces without access to permit entrance of personnel, and except for that piping which is buried in the ground or in concrete.

Printed legends and flow arrows shall be applied at all valve locations, at all points where piping enters or leaves a wall, partition, bulkhead, cluster of piping, or similar obstruction, and adjacent to under-floor lighting, and at approximately 20-foot intervals on pipe

runs elsewhere. Where different equipment is supplied from a common main, the main should be identified and each respective branch takeoff properly identified.

Practicable variations or changes in location and spacing of piping identification may be made with the specific approval of the Engineer to meet specific conditions.

Wherever two or more pipes run parallel, the printed legend and other markings shall be applied properly grouped and neatly arranged.

The markings shall be located so as to be conspicuous from any reasonable point of vantage.

Legend and flow arrow backgrounds shall be in the colors indicated in the "Pipe Marking Schedule." Letters and flow arrows proper shall be black except that yellow letters and arrows may be used where brown background is called for, to permit better visibility. All markers shall be placed with the legend parallel to the pipe run.

The sizes of printed lettering and flow arrows shall be used as follows:

<u>Outside Diameter of Pipe or Covering</u>	<u>Height of Printed Letter</u>	<u>Minimum Length of Flow Arrow</u>
5/8 to 1½ inches	5/16 to ½ inch	1½ inches
2 to 2½ inches	5/8 to 1 inch	1½ inches
3 inches and larger	2 inches	3 inches

The Pipe Marking Schedule shall be as follows:

<u>Legend</u>	<u>Background Color</u>
Air	Green
Blow Off Water	Yellow
Boiler Feed Water	Yellow
City Water	Green
Cold Water	Green
Compressed Air	Green
Condensate	Yellow
Condensate Return-Gravity	Yellow
Condensate Return-Pumped	Yellow
Drinking Water	Green
Fire - Automatic Sprinklers	Red
Fire - Dry Stand Pipe	Red
Fire Protection Water	Red
Fresh Water	Green
Heating Return	Yellow
Heating Steam	Yellow
Heating Supply	Yellow
Hi Press Air	Yellow
Hi Press Condensate	Yellow
Hi Press Steam	Yellow
Hot Water	Yellow
Lo Press Air	Green

<u>Legend</u>	<u>Background Color</u>
Lo Press Condensate	Yellow
Lo Press Steam	Yellow
Plumbing Vent	Brown
Sprinkler Fire	Red
Sprinkler Water	Red
Steam	Yellow
Treated Water	Green

High pressure steam is above 15 psig.

Low pressure steam is 15 psig and lower.

Services not listed shall be provided with suitable legends on colored backgrounds in accordance with American Standards Association Bulletin A-13.

All piping shall be dry and clean of any dirt, grease or loose surface material before application of markers.

Backing cards shall be removed and installation completed in accordance with the manufacturer's application instructions.

In lieu of applying the pressure sensitive, self-adhesive markers, the Contractor may elect to paint the colored backgrounds on piping and stencil letters and flow arrows thereover in accordance with the color requirements specified hereinbefore.

Sewage Pumping Stations. -- Piping and valves furnished and installed in sewage pumping stations, and which are exposed, unless otherwise specified, shall be painted in colors to conform to the following schedule. Services not designated shall be painted as specified in the Special Provisions, or as directed by the Engineer.

<u>Service</u>	<u>Piping</u>	<u>Valves</u>	
		<u>Ring</u>	<u>Spokes</u>
Sewage Influent	Brown	Brown	Brown
Sewage Influent Drain	Yellow-Brown	Yellow	Brown
Sewage Effluent	Black	Black	Black
Sewage Effluent Drain	Yellow-Black	Yellow	Black
Water Supply from Meter to Air Gap	Aluminum	Aluminum	Aluminum
Domestic Water	Blue	Blue	Blue
Domestic Water Drain	Yellow-Blue	Yellow	Blue
Seal Water	Orange	Orange	Orange
Seal Water Drain	Yellow-Orange	Yellow	Orange
Washdown	Green	Green	Green
Washdown Drain	Yellow-Green	Yellow	Green
High Pressure Oil	Purple	Purple	Purple
Fuel Oil	Pink	Pink	Pink

## 502.12 PIPE HANGERS AND SUPPORTS

General. -- All piping furnished and installed in buildings shall be properly and adequately supported and anchored by hangers, brackets, standard clamps, etc., as applicable, as shown on the plans, or, if not

shown, as approved by the Engineer. Any lines which sway, crawl or vibrate shall be supported additionally and braced as necessary, or required. Pipe shall not rest on, nor hang from, other pipelines or equipment.

Plumber's tape or similar strap will not be considered an approved method of support.

Horizontal piping shall be supported in harmony with the exposed structure and, unless otherwise specified, at maximum intervals of ten feet with a separate hanger for each branch over six feet long. Vertical piping, unless otherwise specified, shall be supported by riser clamps at each floor level and at not over ten-foot intervals.

Hangers shall not be attached to the tension side of beams.

Expansion Shields.--All fastenings to concrete, other than inserts, shall be made by using Diamond Expansion Bolt Company expansion shields, Star Expansion double-interlocking expansion shields, or Western Expansion Bolt Company Forway machine bolt expansion shields, or approved equals; except as otherwise noted on the plans or specified in the Special Provisions.

Loads designated by the Engineer as minor may be supported with Phillips Drill Company, or approved equal, flush shells.

Unless otherwise allowed, inserts shall be used for new construction.

#### 502.13 ESCUTCHEONS, SLEEVES AND FLASHING

Escutcheons.--Chromium plated, pressed steel floor and ceiling plates, unless otherwise specified, shall be furnished and set in place on all pipes that pass through finished floors, walls and ceilings in buildings. These plates shall be held securely in place with set screws and set with provision for the movement of the pipes.

Sleeves.--All pipes passing through rough holes made in existing concrete floors, walls and ceilings of buildings, unless otherwise specified or shown on the plans, shall be protected by means of pipe sleeves made of galvanized sheet metal of gauge adequate for rigidity, approximately one inch larger in diameter than, and concentric with, the enclosed pipe and extending the full thickness of the concrete. Where piping is to be insulated, the sleeves shall allow for the full thickness of the insulation, plus one-half inch clearance all around. Pipe sleeves passing through such existing concrete shall have the spaces around the sleeves filled and neatly pointed with an approved cement mortar. Spaces between pipes, or pipes and insulation, and sleeves shall be first packed with oakum and then filled with mastic at both ends.

All pipes passing through smooth machine-cored holes made in existing concrete floors, walls and ceilings of buildings, unless otherwise specified or shown on the plans, shall have the same clearances, packing and mastic as specified hereinbefore.

Pipes shall pass through new building construction, existing concrete walls below grade and concrete floor slabs on ground as detailed on the plans or specified in the Special Provisions.

Flashing. -- Flashing for all piping through roofs, unless otherwise specified, shall be made with sheet lead weighing not less than eight pounds per square foot and extending not less than ten inches in all directions from the pipe. A lead pipe collar of the same thickness, and not less than eight inches in height, shall be attached by a wiped joint. This flashing shall then be counter-flashed with a piece of lead pipe of the same thickness as the collar, turned down inside of the pipe and down over the lead flashing four inches.

502.14 CONTRACTOR TO CLEAN LINES. -- After final assembly, but before making final connections to equipment, pumps, valves, meters, etc., and before final tests are made, the Contractor shall, unless otherwise specified, flush clean the inside of all lines by blowing with air, washing with water, or by other methods approved by the Engineer.

502.15 TESTING. -- Except as otherwise specified or covered by the Municipal Plumbing and Gas Appliance Code, the Contractor shall subject all completed piping and appurtenances furnished and installed under the contract to a hydrostatic test pressure not less than that specified in the Special Provisions. Gravity drainage systems shall be tested by filling the system with water to the highest point of overflow or by subjecting the system to an equivalent pressure. Gauge pressure readings shall stay constant for one hour unless otherwise specified. If leaks exist, the Contractor shall make proper repairs and replacements and repeat the testing until the piping satisfactorily withstands the test pressure. Caulking of leaking threaded joints will not be permitted.

Upon completion of the hydrostatic tests, the Contractor shall put each portion of the work completed under the contract through an operational test, and shall adjust, correct, or properly repair, as the case may be, all leaks and malfunctions revealed by the test until the piping facilities are leak free and operate properly, all as determined by, and to the satisfaction of, the Engineer.

The Contractor shall furnish all equipment, apparatus and materials necessary, or required, to properly conduct the tests.

All testing shall be done in the presence of the Engineer, and where applicable, in the presence of the Chief Plumbing Inspector or his authorized representative.

In order to expedite the work, piping facilities may be tested in sections, as approved by the Engineer.

Testing of all underground piping shall be done prior to backfilling the pipe trenches.

The Contractor shall, when applicable, furnish at his own expense, a certificate of inspection from the Bureau of Building Inspection, Department of Public Works, City and County of San Francisco, certifying that all plumbing system and gas piping regulations have been carried out fully.

## Section 503

### Ductwork, Appurtenances and Accessories Materials and Installation

**503.01 GENERAL.** — All ductwork and appurtenances and accessories, including, where applicable, ducts, turning vanes, dampers, access doors, registers, grilles, diffusers, isolation joints, flexible connections, hangers, supports, etc., shall be as specified herein, or approved equal. All such ductwork and appurtenances and accessories shall be installed by the Contractor where and as shown on the plans, or where directed by the Engineer. All direct drive blower units and exhaustor units shall comply with the applicable sections of the San Francisco Electrical Code.

**503.02 SHEET METAL DUCTS.** -- The duct information shown on the plans is correct for design purposes. The Contractor may vary the location and proportions of the ducts as required by field conditions; however, the equivalent cross-sectional area must remain undiminished.

All ducts shall be diagonally creased for stiffness and all ducts located outside buildings shall be made weatherproof.

Changes in direction or elevation shall be made, wherever possible, only by curved sections, except as otherwise shown on the plans. Changes in sizes of ducts shall be made by uniformly tapering sections.

Every effort shall be made to keep the centerline radius ratio of elbows at 1.5 or more.

Metal ventilation ducts, except as otherwise specified, shall be constructed in accordance with Chapter 12, Tables 9 and 10 of the ASHRAE Guide and Data Book, 1963, which tables are reproduced immediately hereinafter. Any subsequent revisions to these tables, however, shall govern.

Table 9 . . . Recommended Construction for Rectangular Sheet-Metal Ducts

High Pressure	Medium Pressure	Low Pressure			Duct Dimension in Inches	Recommended Construction for Low Pressure
Steel U.S. Std. Gage	Steel U.S. Std. Gage	Steel U.S. Std. Gage	Aluminum B & S Gage	Copper Cold Rolled		Transverse Joints and Bracing
22	24	26	24 (0.020)	16 oz	Up thru 12	S slip, drive slip, 1 in. pocket lock on 8 ft centers.
20	22	24	22 (0.025)	24 oz	13 thru 18	S slip, drive slip, 1 in. pocket lock on 8 ft centers.
20	22	24	22 (0.025)	24 oz	19 thru 30	S slip, 1 in. pocket lock on 4 ft centers. S slip, 1 in. pocket lock on 8 ft. centers with 1 x 1 x 1/8 angles 4 ft from joint. S slip, 1 in. pocket lock on 8 ft centers with cross break 1 in. standing seam on 5 ft centers.
18	20	22	20 (0.032)	32 oz	31 thru 42	1 in. standing S cleat, bar slip, pocket lock on 4 ft centers. 1 in. standing S cleat, bar slip, pocket lock on 8 ft centers with 1 x 1 x 1/8 in. angle 4 ft from joint. 1 in. standing seam on 4 ft centers. Longitudinal standing seam with 1x1x1/8 in. angles on 4 ft. centers.
18	20	22	20 (0.032)	32 oz	43 thru 54	1½ in. standing S cleat, bar slip, pocket lock on 4 ft centers. 1½ in. standing S cleat, bar slip, pocket lock on 8 ft centers. with 1½ x 1½ x 1/8 in. angles 4 ft from joint. 1½ in. standing seam on 3 ft centers.
16	18	20	18 (0.040)	36 oz	55 thru 60	Longitudinal standing seam inside with 1½ x 1½ x 1/8 in. angles on 4 ft centers.
16	18	20	18 (0.40)	36 oz	61 thru 84	1½ in. standing S cleat, bar slip, pocket lock on 4 ft. centers with 1½ x 1½ x 1/8 in. angles 2 ft. from joint. 1½ in. standing S cleat, bar slip, pocket lock on 8 ft. centers with 1½ x 1½ x 1/8 in. angles on 2 ft. centers 1½ in. standing seam on 3 ft. centers. Longitudinal standing seams inside with 1½ x 1½ x 1/8 in. angles on 2 ft. centers.
14	16	18	16 (0.051)	48 oz	85 thru 96	1½ in. standing S cleat, bar slip, pocket lock on 4 ft. centers reinforced with 1½ x 1½ x 3/16 in., or companion angles on 2 ft. centers. 1½ in. standing S cleat, bar slip, pocket lock reinforced with 1½ x 1½ x 3/16 in. or companion angles on 8 ft. centers with 1½ x 1½ x 3/16 in. angels on 2 ft. centers. Longitudinal standing seams inside with 1½ x 1½ x 3/16 in. angles on 2 ft. centers.
14	16	18	16 (0.51)	48 oz	Over 96	1½ in. standing S cleat, bar slip, pocket lock reinforced with 2 x 2 x ½ in. angles, or companion angles on 4 ft centers. 1½ in. standing S cleat, bar slip, pocket lock reinforced with 2 x 2 x ½ in. angles, or companion angles on 8 ft centers with 2 x 2 x ½ in. angles on 2 ft centers. 1½ in. standing seams with 2 x 2 x ½ in. angles on 2 ft centers. Longitudinal standing seams inside with 2 x 2 x ½ in. angles on 2 ft centers.

Note: Where special rigidity or stiffness is required, ducts should be constructed of metal two gage numbers heavier e.g., use 22 gage instead of 24 gage. Ducts larger than 96 in. require special field study for hanging and supporting methods. Other joint construction of equivalent mechanical strength and airtightness may be used. Recommended methods of fastening bracing to ductwork include riveting, bolting, and tack welding. Bracing, stiffening members, or angle connections for copper ductwork, where exposed to the weather, should be of brass or aluminum, of suitable thickness for strength.

**Table 10 . . . . Recommended Duct Construction for Round and Flat-Oval Ducts <sup>a, b</sup>**

Steel U.S. Std. Gage		Size Dia or Max Width	Bracing on Flat Surface
Round	Flat-Oval		
24	22	To 10 in.	None
22	20	11 to 20 in.	1½ x 1½ x 1/8 in. angle or 1½ x ½ x 1/8 in. channel on 4 ft. centers.
20	18	21 to 40 in.	1½ x 1½ x 1/8 in. angle or 2 x ½ x 1/8 in. channel on 4 ft. centers.
18	16	41 to 60 in.	2 x 2 x 1/8 in. angle or 2½ x 5/8 x 3/16 in. channel on 2 ft. centers.
16	14	61 in. and over	2 x 2 x 1/8 in. angle or 2½ x 5/8 x 3/16 in. channel on 2 ft. centers.

<sup>a</sup> All fittings should be of same gage as pipe or heavier.  
<sup>b</sup> Satisfactory for pressure in duct up to 10 in. water.

Bolted joints shall be made air-tight with approved chromate gasketing, 3/4-inch wide.

All field joints shall be taped for vapor and air-tightness with an approved tape.

Elbows and transition sections shall be formed with Pittsburgh corner seams.

Double compounded elbows and other complicated fittings shall be constructed with double-seam corners.

**503.03 TURNING VANES.** -- All elbows having centerline radii of less than 1.5 times the width of the duct in the direction of the turn, including all square-turn elbows, shall be fitted with turning vanes so designed that each elbow loss will not exceed, by 10 percent, the normal loss in an elbow having a centerline radius 1.5 times the duct width. Turning vanes shall be riveted securely to the sides of ducts at the correct angle.

**503.04 SPLITTER DAMPERS.** -- Adjustable splitter type deflector dampers, each of length equal to one-half the width of the duct, shall be furnished and installed where shown on the plans for branch ducts or wherever necessary to provide complete control for balancing air flows as called for on the plans. Dampers shall be constructed to conform to Figure "B", Plate No. 28, of SMACNA "Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems" (with

all supplements issued) and as shown on the plans. Each damper shall be located so that it will be readily accessible for inspection and adjustment. All metal parts shall be galvanized or treated with rust inhibitor after assembly.

503.05 ACCESS DOORS. — Access doors shall be provided on ducts at all fire damper locations and wherever access for cleaning and servicing of equipment will be required. Duct access doors shall be constructed to conform to Plates Nos. 30, 31, and 32, of SMACNA "Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems" (with all supplements issued) and as shown on the plans.

503.06 REGISTERS, GRILLES AND DIFFUSERS. — Registers, grilles and diffusers shall be as indicated on the plans or in the Special Provisions and shall be fitted with sponge or foam rubber gaskets under the rims to prevent smudging of adjacent surfaces.

503.07 ISOLATION JOINTS. — Dielectric isolation strips of an approved chromate gasket material shall be furnished and installed at all points of connection of aluminum and steel or of aluminum and brass.

503.08 FLEXIBLE CONNECTIONS. — Flexible connections, in general, shall be made with neoprene impregnated canvas, or other approved similar type connection material, designed to prevent the transmission of vibrations, and shall be attached securely to fans or blowers and ducts with metal bands and clamps, but not stretched too tightly.

Flexible connections between fans or blowers and ducts for sewage pumping and treatment plant ventilation systems shall be made with approved 32-ounce weight, heavy grade, fiberglass fabric coated with neoprene, which shall be resistant to alkalis, acids, corrosive gases, oils, solvents and greases, and shall withstand high pressures and vacuums. The fabric shall be fastened to fans or blowers and ducts with an approved nonpourable cement, applied in a band 1/8-inch thick by 4 inches wide and bonded securely in place with bolted 2-inch wide straps. The straps shall be tightened to allow a layer of nonpourable cement, 1/8-inch thick, to remain between the duct and the fabric to form a flexible vapor and pressure-tight joint.

503.09 HANGERS AND SUPPORTS. — Hangers and supports for ducts shall be furnished and installed to conform with the applicable Plates in the SMACNA "Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems" (with all supplements issued) and as shown on the plans.

All sharp, exposed angles and surfaces on hangers over, or adjacent to, walkways shall be rounded.

503.10 LOCATION OF DUCTS. — All ducts shall be run parallel and perpendicular to floors, walls and ceilings, and shall follow the general lines of rooms to make a neat and, where applicable, symmetrical, installation. All ductwork shall be located near the ceiling or shall hug walls in order to give a maximum of headroom and free space.

503.11 PROTECTION OF FANS IN SEWAGE PUMPING AND TREATMENT PLANTS. — The interior surfaces of ventilating fans, furnished and installed in sewage pumping and treatment plants, shall be painted with "Amercoat", or approved equal, material, which shall resist corrosion by hydrogen sulfide, ammonia and other common sewage gases and vapors under dry and wet conditions. Coatings and preparation shall be as follows:

Surfaces to be painted shall have all weld splatter removed, rough welds and sharp edges ground smooth, and shall be dry sandblasted to provide a surface free of all millscale, rust, paint or foreign matter. Immediately thereafter one prime coat of "Amercoat" No. 23 Prime Coat, or approved equal, shall be applied. After priming, two coats of "Amercoat" No. 23 Body Coat, or approved equal, and three coats of "Amercoat" No. 33 Seal Coat, or approved equal, shall be applied. Total film thickness shall be not less than .010 inches (10 mils).

503.12 BALANCING OF VENTILATION SYSTEMS. — The Contractor shall balance the ventilation systems to provide the air quantities indicated on the plans for each outlet.

Immediately before balancing, all dampers shall be placed in a neutral position, the rotating equipment shall be lubricated and checked for proper rotation, and air filters shall be cleaned thoroughly.

The Contractor shall begin by taking readings across the supply or return fans with a calibrated anemotherm, velometer or Pitot tube. Care shall be taken to obtain an average velocity over each face area. All registers, grilles and diffusers shall then be read and adjusted to obtain the proper quantity and diffusion of air in each area. After all dampers have been adjusted and the systems are balanced, the Contractor shall submit to the Engineer six (6) copies of a list of all outlets indicating the outlet location, air quantity in cubic feet per minute, and air velocity in feet per minute. In addition, the Contractor shall list the fan speed and motor speed, current and voltage.

The Contractor shall furnish all testing equipment and materials necessary, or required, for balancing of the air systems, all subject to the approval of the Engineer.

## Section 504

### Excavating, Backfilling, and Restoring Pavements and Related Improvements

The Contractor, as Incidental work, shall do all excavating, backfilling, and restoring of pavements and related improvements necessary, or required, for the proper installation of mechanical equipment, piping, and appurtenances.

Where the existing finished pavement surface is concrete, including concrete parking strip, concrete gutter, and concrete sidewalk, all cuts therein between pavements to be removed and those to remain in place shall be made in accordance with the applicable requirements of Section 201.02.

Trenches and other excavations shall be made safe and passable by the use of barricades, bridges and other approved means, and, unless otherwise allowed, shall have vertical sides.

Excavations shall be such that piping installed in lawn and other planted areas, under center or traffic island pavement, under sidewalk areas, and under roadway pavement, shall have the minimum covers specified in Section 502.01.

Backfilling shall not commence until after structures, mechanical equipment, piping, and appurtenances have been properly constructed, or furnished and installed, as applicable, and inspected.

Except as otherwise specified, site-excavated materials may be used for all backfill. Backfill shall be free of debris, wood and other organic or deleterious matter.

All backfill other than sand shall be placed in horizontal layers not more than 8 inches thick before compaction, and each layer shall be satisfactorily compacted by mechanical means. Sand backfill shall be flooded or jetted, or compacted by other approved means, in horizontal layers not more than 3-feet thick.

All backfill in roadway areas shall be compacted to a minimum relative compaction of 90 percent. All other backfill shall be compacted to a relative compaction matching that of the existing adjacent ground.

The term "Relative Compaction" means the percentage ratio of the field-compacted dry density to the maximum dry density obtainable by compaction at optimum moisture content.

The methods of testing compaction, including determination of optimum moisture content and maximum density, shall be in accordance with ASTM "Standard Methods of Test for Moisture-Density Relations of Soils, Using a 10-lb. Rammer and an 18-in. Drop", Designation D1557.

Compaction tests, as required by the Engineer, on the particular material used will be conducted and evaluated by the City at no cost to the Contractor.

Pavements and related improvements shall be restored in accordance with the requirements of Section 108.09, and construction thereof shall be in accordance with the applicable requirements of Part II of these Standard Specifications.

## **Section 505**

### **Payment**

Mechanical work, satisfactorily constructed or furnished and installed as specified, will be paid for at the lump sum price bid therefor, except as otherwise specified in the Special Provisions.

## PART VI

### ELECTRICAL WORK

#### Section 600

#### General Requirements

600.01 RULES AND REGULATIONS. --All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratories, Inc. (UL), or the Electronic Industries Association (EIA), wherever applicable.

In addition to the requirements of the Special Provisions, the plans, and these Standard Specifications, all materials and workmanship shall conform to the requirements of the National Electrical Code; the Electrical Safety Orders of the State of California Division of Industrial Safety; the General Orders of the Public Utilities Commission of the State of California; the Municipal Building and Electrical Codes of the City and County of San Francisco; the current Standardization rules of the Institute of Electrical and Electronic Engineers; and all other applicable local, state, and federal rules, regulations and statutes governing the installation of electrical work.

Wire sizes shall be based on American Wire Gage (AWG).

600.02 PERMITS. --The Contractor shall obtain, at his own expense, prior to start of any electrical work in buildings and in other locations outside of street areas, all necessary permits from the Department of Public Works for the work covered by the specifications, and shall deliver the certificate of final inspection to the Engineer upon completion of the work.

600.03 ADJUSTMENT OR RELOCATION OF EXISTING FACILITIES. --If required to permit the prosecution of the work, the adjustment or relocation, as approved by the Engineer, of existing electrical conduit and contained wires, existing pipes or existing ducts, where such conduit and pipes are  $1\frac{1}{4}$  inches or less in nominal diameter and the ducts are one square foot or less in cross-sectional area, shall be considered Incidental Work. The adjustment or relocation of larger sized existing facilities, however, unless specifically indicated for such adjustment or relocation on the plans or in the Special Provisions, if necessary, as determined by the Engineer, shall be done as directed, as Extra Work in accordance with the requirements of Section 111.

600.04 FLOOR, WALL AND CEILING OPENINGS. --The Contractor shall secure the Engineer's approval of the locations for holes and openings in floors, walls and ceilings, necessary for the installation of electrical equipment, conduit, and appurtenances, and shall keep to

a practicable minimum the size of such holes and openings. All requirements of Section 500.04 shall apply to the work under this Section and the cutting requirements of such Section 500.04 shall apply to sidewalk directly above basements.

600.05 UNINSPECTED WORK NOT TO BE CLOSED IN. --The Contractor shall not cover up nor enclose any of his work until it has been tested by him in the presence of the Engineer if testing is required, and until it has been inspected and approved by the Engineer. Should any of the work be enclosed or covered up before such testing and inspection, the Contractor shall, at his own expense, uncover the work and, after it has been tested, inspected and approved, restore such covering and enclosure.

600.06 ALTERATIONS TO EXISTING CONDUIT IN STREET AREAS. --Existing conduits, installed under previous contracts, shall be used and altered as necessary, where, as, and to the extent, shown on the plans.

The Contractor shall locate existing conduits by means of pipe locators, tapping or other means at each location before excavating therefor. All such work and any other exploratory work shall be considered Incidental Work.

The Contractor shall alter and, by additional conduit, extend existing conduits as necessary, or required, to make the required connections. Such extensions by additions of new conduit will be paid for under the appropriate conduit Bid Item. Alterations to existing conduits, however, will be considered Incidental Work. Such alterations shall include finding, exposing, cutting, bending the terminal 3 feet after cutting, if any, and threading, all as required.

In each case where alterations to existing conduit are involved, the Contractor shall furnish and install conduit only to the point of interception of the existing conduit, but shall not disturb the existing installation, until prepared to effect the temporary relocation or permanent installation within the specified time limit on shutdown.

Where existing conduits are shown on the plans to be used and any portions thereof are too high, or the ends and terminal elbows thereof are rusted or lack threads, the Contractor shall furnish and install conduit, elbows, and nipples to replace exposed existing conduit. Such conduit replacement will be paid for at the price bid under the applicable conduit Bid Item, subject, however, to the limitation that work to the extent hereinbefore specified to be "alterations" shall be done as Incidental Work.

Where existing metallic conduits are extended into new concrete pull boxes, the conduits shall be fitted with bushings, and grounded as specified in Section 602.13.

600.07 CURB MARKING OF CONDUIT LOCATIONS. --The Contractor shall mark each location where City-owned conduit, furnished and installed or encountered and exposed, as the case may be, by him, crosses under the curb, by cutting an identifying letter in the curb di-

rectly over each such conduit. Identifying letters shall be approximately 2 inches high, legibly cut or impressed, as the case may be, with chisel or die, and shall be in accordance with the following legend:

<u>Type of Conduit Crossing Curb</u>	<u>Identifying Letter</u>
Traffic Signal Conduit	T
Street and Safety Lighting Conduit	L
Fire Alarm and other Department of Electricity Conduit	D

All identifying letters shall be cut or impressed in the presence of the Engineer, with the conduit exposed. Backfill over such conduit shall not be placed before the curb has been marked.

600.08 ELECTRIC SERVICE. --Service equipment, materials and connections shall comply with the current rules of the Pacific Gas and Electric Company.

Service points shown on the plans are approximate only. The Contractor shall determine from the Pacific Gas and Electric Company exact service points and, if any, riser locations.

The Contractor shall communicate with the Pacific Gas and Electric Company to determine the extent of the work that that company will perform, and what materials for the service he must furnish. The Contractor shall make all arrangements with the Pacific Gas and Electric Company for the setting of meters and connection of electric services.

The Contractor shall be responsible for all materials and services required of him and for all charges by the Pacific Gas and Electric Company, including any charges for energy used during testing, adjusting of the work or for energy supplied for construction purposes. He shall do such work, furnish such materials and pay such charges as Incidental Work, payment for which shall be included in the price or prices bid.

600.09 SERVICE INTERRUPTIONS. --Where work under the contract requires connection to existing services and it is necessary to keep the existing facilities in operation, as determined by the City, all service interruptions shall be held to a minimum and shall be scheduled in advance by the Contractor and approved by the Engineer.

Work at overtime rates, resulting from the specified requirement that service cut-over operations be made at other than regular working hours, shall be done at no additional cost to the City.

600.10 SAFEGUARDING FIRE ALARM SYSTEMS. --The Contractor shall not cut into any existing City fire alarm conduit, shall not disturb, splice or cut any existing City fire alarm wiring, and shall take every precaution necessary, or required, to protect such conduit and

wiring.

He shall be responsible for the repair or replacement, as required, to the satisfaction of the General Manager of the Department of Electricity and the Engineer, of any damage to existing fire alarm facilities resulting from his operations.

600.11 WORK IN UTILITY MANHOLES AND VAULTS. --The Contractor shall conduct his work in manholes and vaults of the Pacific Telephone and Telegraph Company, the Pacific Gas and Electric Company, the Public Utilities Commission of the City and County of San Francisco, the Department of Electricity, and in all other manholes and vaults not owned by the Department of Public Works, in strict accordance with the standard practices of the affected owners thereof. He shall notify the owners of manholes or vaults at least forty-eight (48) hours before commencing work therein.

The Contractor shall not commence the installation of conduit into any manhole or vault until an authorized representative of the owner thereof has designated the point of entry of the conduit. The Contractor shall install the conduit where designated. He shall not connect or disconnect any wire or cable, except that exclusively for traffic signal control, in any such manhole or vault.

All persons entering or leaving manholes or vaults shall do so only by ladders, so as to avoid damage to cables and other facilities.

Suitable barricades shall be placed around each open manhole, and a flagman shall be stationed at the manhole during the entire time the manhole cover is off, in accordance with the applicable requirements of Section 109.12.

600.12 TESTING OF TRAFFIC SIGNAL CONTROLLERS OR MODIFICATIONS THERETO. --Each traffic signal controller, or modification to be installed in an existing traffic signal controller, not more than forty-eight (48) hours prior to the installation thereof, shall be given the operational test specified herein, in the presence of the Engineer. The Contractor shall arrange to have the test performed either on his premises or on the premises of the controller equipment manufacturer's representative.

The test shall be conducted with all time settings and cam breakouts made as directed by the Engineer. The controller, or the equipment modifying an existing controller, shall be connected to a "dummy" incandescent lamp load equal to that to which it will be connected in the field, and shall operate continuously for one hour under such load. If the controller is a multi-dial, fixed-time controller, the time shall be divided equally between each dial unit.

All loose connections, arcing contacts, noisily operating relays, or malfunctioning appurtenances revealed by the test, shall be corrected, and the applicable portions of the test repeated until all component parts operate satisfactorily.

600.13 STREET LIGHTING CIRCUITS. --Primary street lighting circuits, when completed, shall be subjected to a high voltage test. The

type and capacity of the test equipment shall be adequate within the range of test voltages. The test equipment shall be capable of being, and shall be, calibrated so that voltage readings during such tests will be accurate to within plus or minus 2 percent.

Insulated conductors for series street lighting systems, rated for service at 5,000 volts, shall withstand the application of a test voltage of 8,400 volts, 60-cycle AC, RMS.

In lieu of the foregoing alternating current high voltage test, the Contractor may, at his option, conduct the test with direct current, in which case the d-c test voltage shall be 25,200 volts.

The test voltage shall be applied between the conductor of the circuit and its enclosing conduit for a period of five (5) consecutive minutes, with the two ends of the conductor connected together to form a continuous loop and the conduit grounded. The test voltage shall be increased from zero at a uniform rate of rise approximating, but not exceeding, 3 kv per second.

All materials and other parts of the installation revealed by the test to be inferior or defective, shall be satisfactorily replaced, except that defective materials or parts that can be satisfactorily repaired, may be repaired in lieu of being replaced. Following such replacement and repair, as applicable, the test shall be repeated, and necessary replacements and repairs made, until the entire installation satisfactorily carries the test voltage without the appearance of defects.

After the high voltage test has been satisfactorily completed, the installation shall be connected to the permanent source of power for a service test, the duration of which shall be not less than one (1) hour. If any defects appear, correction shall be made as specified in the preceding paragraph and the entire test procedure, including the high voltage test, repeated until the system satisfactorily carries its permanent service load for not less than one (1) hour without the appearance of defects.

#### 600.14 NAMEPLATES AND SIGNS

General. --Unless otherwise specified on the plans or in the Special Provisions, the Contractor shall furnish and install nameplates and signs in accordance with the following provisions:

Nameplates - Where Required. --The following shall be equipped with nameplates:

- 1) All motors, motor starters, motor control centers, push button stations, control panels, and time switches;
- 2) Disconnect switches, fused or unfused; switchboards and panelboards; circuit breakers, contactors, or relays in separate enclosures;
- 3) Power receptacles where the nominal voltage between any pair of contacts is greater than 150 volts;
- 4) Wall switches controlling outlets for lighting fixtures or equipment, where the outlets are located not within sight of the controlling switch;
- 5) Telephone, intercom, radio, television and other special electrical systems shall be properly identified at junction and pull

- boxes, terminal cabinets, and equipment racks;
- 6) Signal outlets, such as antenna, radio, television, microphone, audio-visual, and controls, such as volume controls and channel selectors; and
- 7) High voltage boxes and cabinets.

In addition, terminal blocks shall be furnished with legend strips, properly inscribed with circuit function or to correspond with notations on pertinent wiring diagrams. Legend strips shall be enclosed in clear plastic sheathings.

Nameplates - Inscription. --Nameplates shall adequately describe the function or use of the particular equipment involved, and shall be subject to approval of the Engineer. Where nameplates are detailed on the plans, inscription and size of letters shall be as shown.

Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply; for example: "Panel A, 277/480 V, 3 ph."

The name of the machine on the motor nameplates for a particular machine shall be exactly the same as that used on all motor starter, disconnect and push button station nameplates for that machine.

Nameplates - Construction. --Nameplates shall be laminated phenolic plastic, black front and back with white core, with lettering etched through the outer covering. Lettering shall be 3/16-inch high at push button stations, thermal overload switches, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4-inch high, unless otherwise detailed on the plans. Nameplates shall be securely fastened to equipment with No. 4 Phillips, round-head, cadmium-plated steel self-tapping screws or nickel-plated brass bolts.

Motor nameplates may be of non-ferrous metal not less than 1/16-inch thick, die stamped.

In lieu of separate plastic nameplates, engraving directly on device plates is acceptable, if approved by the Engineer. Engraved lettering shall be filled with either black or white enamel, as determined by the Engineer.

Warning Signs. --Warning signs shall be furnished and installed in accordance with the following provisions:

- 1) On enclosures containing high voltage equipment, the signs shall read, "DANGER - HIGH VOLTAGE - DO NOT ENTER." Signs shall be 7 inches x 14 inches, with all lettering 1 inch high, except the word "DANGER" which shall have 1½-inch high letters. The aforementioned dimensions are minimum requirements.
- 2) On non-load disconnects and cutouts, the signs shall read "DO NOT OPEN UNDER LOAD." Letters shall be 1 inch high, minimum.

Warning signs shall be of standard manufacture, fabricated of No. 18-gauge steel, or heavier, with a porcelain enamel finish. Letters shall be red on a white background.

High Voltage Marking. --All high voltage boxes, cabinets, and conduits in exposed or accessible locations shall be marked with the letters "HIGH VOLTAGE." Markings shall be either by means of stenciling or

with approved, pressure sensitive, self-adhesive markers.

The markings shall be located so as to be readily conspicuous at all times from any reasonable point of vantage. All surfaces to be identified shall be dry and clean of any dirt, grease or loose surface material before application of markers. Backing cards shall be removed and installation completed in accordance with the manufacturer's instructions.

Letters shall be black on an orange background, not less than 1-7/8 inches high. If the dimensions of the surfaces to be marked deem the use of 1-7/8-inch high letters impracticable, then a smaller size lettering shall be used, all as determined by the Engineer. On conduit runs, markings shall be applied at intervals not exceeding 10 feet in any individual area. All markings shall be made after painting of all other work under the contract has been completed. Freehand lettering will not be acceptable.

600.15 WIRING DIAGRAMS.--All cabinets housing electrical equipment, controls and protective devices, including terminal cabinets, shall each be furnished with a wiring diagram laminated in clear plastic.

Each wiring diagram shall describe the function and list the manufacturers and catalog numbers of all equipment, controls and protective devices shown thereon. All wiring shall be labeled as to circuit function and color coding.

In addition, The Contractor shall furnish and install a new wiring diagram in existing cabinets to which he has made modifications or circuit changes, or when modifications or circuit changes made by him affect the existing equipment within the cabinets. Existing wiring diagrams shall remain the property of the City, and the Contractor shall deliver them to the Engineer. Each replacement wiring diagram shall be properly dated, and shall make reference to the origin and number of the plan it supersedes.

New wiring diagrams shall be furnished with brass eyelets, stainless steel screws, nuts, shakeproof washers and brass springs, and shall be securely attached to walls or doors of cabinets.

600.16 PRESERVATION AND CLEANING.--After all other work in the area, including sanding and painting, has been completed, electrical equipment such as lighting fixtures, panelboards and switchboards shall be cleaned to remove all dust, dirt, grease or other marks, and the work left in a condition satisfactory to the Engineer.

## Section 601

### Electrical Equipment, Materials and Appurtenances

**601.01 GENERAL.**--All electrical equipment, materials, and appurtenances shall be new, of the best quality, of the brand or make designated, or an approved equal thereof, and in accordance with the requirements of this Part VI, unless otherwise specified on the plans or in the Special Provisions.

#### **601.02 CONDUIT AND FITTINGS**

**General.**--Each length of conduit shall bear the label of the National Board of Fire Underwriters and the name of the manufacturer. All surfaces of conduit and fittings shall be free of obstructions, projections, roughness, blisters, scale, sharp edges and rust. Conduit shall be in accordance with the latest requirements of the National Electric Code.

**Rigid Steel Conduit.**--Rigid steel conduit shall be new, standard weight wrought steel pipe, zinc-coated on the exterior and interior surfaces by a hot-dip galvanizing process, coated on the interior surfaces with lacquer or enamel, and furnished with plastic thread protectors.

All conduit fittings, such as couplings, elbows, outlet boxes, junction boxes, caps and locknuts, shall be screwed fittings, and shall be subject to the same requirements as for rigid steel conduit.

Rigid steel conduit for aboveground use in buildings, except conduit buried in concrete, unless otherwise specified, may have sherardized or equivalent coating in lieu of zinc coating.

**Rigid Aluminum Conduit.**--Rigid aluminum conduit shall be standard weight, seamless pipe of aluminum alloy containing not more than 0.10 percent copper and shall comply with the latest ASA Specification for rigid aluminum conduit. A petroleum base lubricant containing powdered zinc shall be factory applied to the threads at both ends of the conduit. The interior surfaces of conduit and elbows shall be coated at the factory with an approved lubricant.

All conduit fittings, such as couplings, elbows, outlet boxes, junction boxes, caps and locknuts shall be aluminum screwed fittings, and shall be subject to the same requirements as for rigid aluminum conduit.

**Electrical Metallic Tubing.**--Electrical metallic tubing shall be cold rolled steel tubing with a zinc coating on the outside and a protective enamel coating on the inside.

Fittings shall meet the same requirements for finish and materials as electrical metallic tubing.

**Flexible Conduit.**--Flexible conduit shall be spirally wound continuous length steel strip with a continuous zinc coating. Fittings shall be of an approved type which clamp the flexible conduit securely to the fitting.

Liquid-tight flexible conduit shall be hot-dip galvanized, spirally wound continuous length steel strip, with continuous extruded polyvinyl covering and watertight connectors.

Rigid Plastic Conduit. -- Rigid plastic conduit and fittings shall be impervious to soil or environmental chemicals. Underground conduit shall be designed for direct burial use and shall have a minimum wall thickness of 1/8 inch. Only virgin materials shall be used in the manufacture of conduit. Conduit containing reclaimed materials will be rejected.

Asbestos-Cement and Fiber Conduit and Fittings. -- When asbestos-cement, sometimes known and herein referred to as "transite," conduit is specified, it shall be Johns-Manville "Transite," or approved equal, conduit.

Fiber conduit shall be Orangeburg "Nocrete," or approved equal, conduit.

Ends of each length of transite and fiber conduit shall be perpendicular to the sides and shall be so cut that no sharp edges will come in contact with the cables, or wires.

All fittings for transite conduit, such as couplings, bends and bells, shall be made of transite, and for fiber conduit shall be made of fiber. In all cases, fittings shall be of the same manufacture as the conduit.

601.03 CONCRETE. -- Concrete for pull boxes, for junction boxes, and for foundations for electrical structures and equipment shall be Class "B" in accordance with the requirements of Section 900.11. Concrete for pressure-type vehicle detectors shall have 2 pounds of calcium chloride per sack of cement added to the concrete mix in accordance with the requirements of Section 900.08.

601.04 MISCELLANEOUS MATERIALS, DEVICES, AND APPURTENANCES. -- The following materials, devices, and appurtenances shall be used in electrical construction, as required:

Caps for rigid steel conduit shall be hot-dip galvanized malleable iron pipe caps. Caps for rigid plastic conduit shall be fabricated from virgin polyvinyl chloride (PVC) and shall have a minimum wall thickness of 1/8 inch.

Concrete Sealing Compound shall be Conrad Sovig Company, "Sulco," or approved equal, iron compound.

Conduit Bushings shall be OZ Electric Company, Type BL, or approved equal, code approved grounding bushings of the proper size.

Conduit Clamps shall be one-hole, hot-dip galvanized, malleable iron, of the proper size.

Fastenings for Conduit Clamps on steel poles shall be 1/4-inch-20 x 3/4-inch stainless steel machine screws complete with stainless steel shake-proof washers.

Conduit Sealing Compound shall be Johns-Manville "Duxseal," or approved equal.

"Erickson" Conduit Couplings shall be Thomas and Betts Company, or approved equal, of the proper size.

Expansion Shields for attaching conduit straps and electrical equipment to concrete standards shall be Star Expansion Bolt Company, "Star Tampin," or approved equal, with closed bottoms, of adequate size, but not larger than 3/8-inch diameter. Ex-

pansion shields for attaching conduit straps and equipment to concrete and masonry shall be Star Expansion Bolt Company, "Star Double," or approved equal, each of the size shown on the plans or specified in the Special Provisions.

Grounding Bushings shall be OZ Electric Company, Type BL, or approved equal, code approved threaded set screw grounding bushings, complete with screw type, solderless pressure lugs of the proper size.

Grounding Clamps shall be Burndy Corporation, "Groundem," Type GH, or approved equal, for 5/8-inch ground rods.

Grounding Fittings for conduit and pipe shall be Thomas and Betts Company, Catalog Nos. 3092 to 3909 Bulletin 85, or approved equals.

Grounding Rods shall be Hubbard and Company, Catalog No. 2670, or approved equal, 5/8 inch x 10 feet long.

Grounding Wedges shall be Thomas and Betts Company, or approved equal, of the proper size.

Grounding Wire shall be bare stranded copper wire of the AWG size required by code, except that it shall not be smaller than No. 6 AWG.

Lag Screws for Conduit Clamps on wooden poles shall be 1/4 inch x 2 inches hot-dip galvanized steel.

Screws for Bonding and Grounding shall be 1/4-inch - 20, round head stainless steel machine screws, and each screw shall be furnished with a stainless steel nut and a stainless steel shake-proof washer.

Soldering Paste shall be M.W. Dunton Company, "Nokorode," or approved equal.

Tapes and Adhesives for wire and cable splicing shall be Minnesota Mining and Manufacturing Company products, or approved equals.

Vertical Cable Supports shall be "Kellems Grips," or approved equal.

Signal Heads shall be 3-section, standard products modified as specified herein, of the Econolite Corporation, Eagle Signal Company, Crouse Hinds Company, or Southern Switch and Signal Company, or approved equal in all respects to the products of such companies, as determined by tests and examination by the City of submitted samples.

The signal heads shall be assembled as "one-way," "two-way," "three-way," "four-way," or otherwise as shown on the plans. Each signal head shall include a Square "D" Company Class 9080 Type CA, or approved equal, 4-pole terminal block, which shall be installed on signal standards or on lighting or trolley poles, as shown on the plans.

The three sections of each signal head, also known as "way" or "face," shall be provided with red, amber and green lenses, respectively. A silvered glass parabolic reflector and other accessories, such as socket, wiring and terminals, shall be included in each section of each signal head.

The doors and housings of the signal head sections shall be of high-strength aluminum alloy. All exposed bolts, screws, hinge pins and door catches shall be stainless steel. All interior screws and fasteners shall be stainless steel or other approved non-ferrous, corrosion-resistant material.

Lens and reflector gaskets shall be neoprene. Lamp holder gaskets shall be fiber. Door gaskets shall be neoprene or canvas wicking.

A hood, approximately 8 inches long unless otherwise shown or specified which shall completely encircle each lens, shall be provided on each signal head section. The hoods shall be made of sheet aluminum or hot-dip galvanized, copper-bearing steel not less than 1/16 inch in thickness. The hoods shall be designed to tilt downward from the horizontal plane. Each hood shall be fitted to the signal head in such manner that the signal light cannot be seen between the hood and the signal head from either side.

All surfaces of each housing, including doors and hoods, shall be coated with an approved primer and finished with two (2) coats of oven-baked enamel. If such coating is chipped or scratched off before final acceptance of the work, the Contractor shall clean the damaged surface of dirt and grease and, immediately after, shall coat it with two (2) applications of an approved enamel.

Unless otherwise specified in the Special Provisions, each signal head section shall be provided with a traffic signal lamp rated 67 watts, at 125 volts, and having a rated life of 6,000 hours, which rating and voltage shall be etched on the end of the bulb. Each bulb shall be gas filled, of Type A-21 shape, and the filament shall have at least five equally spaced supports between its terminals. Each lamp shall have a light center length of 2-7/16 inches, maximum overall length of 4-7/16 inches, minimum initial lumens of at least 600, and its light distribution shall be in accordance with the standards of the Institute of Traffic Engineers. The Contractor shall submit the lamp manufacturer's data sheets showing compliance with these requirements.

The complete design and construction of the signal heads, including accessories, shall be of the highest quality, and shall conform to the recommendations of the Institute of Traffic Engineers.

## Section 602

### Installation of Electrical Equipment

602.01 GENERAL. --All electrical installations, including those of a temporary nature, shall be made in a workmanlike manner and shall be so designed, constructed, and installed that hazard caused by the disturbance thereof will be eliminated or reduced as far as reasonably possible. Installations of new utilization equipment and conductors, and extensions, repairs and changes in existing installations shall be made only by, or under the supervision or direction of, qualified persons.

602.02 CONTRACTOR TO HAUL ELECTRICAL EQUIPMENT TO AND FROM CITY YARDS. --All electrical equipment, appurtenances, and materials furnished by the City to the Contractor for use in the work, shall be handled, loaded and hauled by him from the Department of Electricity Warehouse at 901 Rankin Street, or other locations within the City limits specified in the Special Provisions, to the site of the work. Any materials or equipment damaged by the Contractor during loading, temporary storage, hauling or unloading shall be repaired, repainted or replaced, as applicable, by him at his sole expense and to the satisfaction of the Engineer.

All surplus electrical equipment, appurtenances and materials, salvaged or otherwise, on the site of the work, or in the possession of the Contractor, and not used in the work nor specified to be abandoned, that remain or become the property of the City, shall be loaded and hauled by the Contractor to the Department of Electricity Yard, or other locations within the City limits directed in the Special Provisions, and shall there be placed by him where directed by the Engineer.

Before disturbing any existing equipment to be salvaged as City Property, the Contractor shall ascertain, in the presence of the Engineer, the condition of such equipment.

The Contractor shall obtain from the Department of Electricity's representative, or from the individual in charge of the storage facility, two (2) copies of the receipt of salvaged material, one copy of which he shall deliver to the Engineer. The receipts shall be properly itemized and shall state the condition of the equipment at the time of delivery. Any salvaged material or equipment damaged by the Contractor during removal, temporary storage, loading, hauling or unloading shall be repaired or replaced, as applicable, by him at his sole expense and to the satisfaction of the Engineer.

All deliveries to and from the Department of Electricity Warehouse at 901 Rankin Street, or other locations within the City limits directed in the Special Provisions, shall be made only by prior appointment with the individual in charge of the storage facility.

#### 602.03 CONDUIT AND FITTINGS

General. --All conduit and fittings shall be in accordance with the

requirements of Section 601.02.

All non-metallic conduit not encased in concrete shall have a minimum of 30 inches of cover, measured from the finished ground or pavement grade, as applicable. All non-metallic conduit encased in concrete, and all metallic conduit, shall have a minimum of 18 inches of cover, measured from the finished ground or pavement grade, as applicable.

All plastic conduits shall be furnished with a No. 6 AWG bare stranded copper wire installed alongside the conduit, which shall loop in and out of pull boxes and terminate on neutral busses in cabinets of electrical equipment.

Street lighting conduit installed in sidewalk areas for lighting standards located at the curb shall be laid within 12 inches of the curb line, unless otherwise shown on the plans or specified in the Special Provisions.

All conduit damaged on the job, before and during installation, and not acceptable to the Engineer, shall not be used in the work, and shall be removed from the job site immediately upon notice.

Where underground conduit changes direction, long radius sweeps shall be used instead of short bends, and in no case, except at foundations or where otherwise specified, shall a bend radius of less than 30 inches be used.

Bends at foundations or other underground structures shall be of maximum possible radius, in no case less than 12 times the internal diameter of the conduit. Conduit shall not be flattened in bending, and shall be free of kinks and indentations. In addition, unless otherwise directed, the maximum number of bends in any one conduit run shall be as follows: a run of conduit between the bases of standards and controller pedestals shall not contain more than the equivalent of two (2) 90° and one (1) 45° bends; a run of conduit between pull or junction boxes shall not contain more than the equivalent of three (3) 45° bends; a run of conduit between the base of a standard or controller pedestal and pull or junction box shall not contain more than the equivalent of one (1) 90° and one (1) 45° bend. The heating of any metallic conduits for the purpose of bending is prohibited.

Where metallic conduits enter panel boxes, pull boxes, or outlet boxes, except where entering prefabricated concrete pull boxes or the bases of standards, the conduits shall be secured in place by galvanized locknuts and bushings, one locknut inside and one locknut outside the box, and a bushing on the conduit end, all drawn tight to insure perfect electrical and mechanical contact. The locknuts shall be tightened against the box without deforming the box. Insulating bushings shall be installed as required by code. Insulating bushings shall have the insulating material permanently fastened to the fittings.

A minimum separation of 6 inches shall be maintained between conduits and steam or hot water lines.

Where conduit runs are exposed, whether singly or in multiple runs, whenever possible they shall be installed straight and true, parallel with respect to each other and the adjacent construction, or perpendicular thereto.

Where parallel runs of conduits are installed in a common trench, such conduits shall be spaced 6 inches on centers measured in a horizontal plane.

Neither perforated strapping nor steel wire will be acceptable as conduit supports.

Conduits which terminate in the bases of standards shall extend 2 inches above official curb grade, and shall be threaded. All conduits entering the bases of standards shall be fitted with conduit bushings.

Where shown on the plans, the Contractor shall install spare rigid steel conduit elbows in foundations. The exact locations of these elbows in the foundations will be determined in the field by the Engineer. The exposed ends of such elbows shall be terminated in a grounding bushing and grounded to the metallic surfaces of electrical equipment. The subsurface ends of the elbows shall be capped.

Conduits installed in existing foundations of lighting standards and trolley poles shall be located as directed by the Engineer, and shall be securely grouted in place in a neat and workmanlike manner in such a way that the foundation is not weakened.

Conduits installed on the surfaces of lighting standards and trolley poles, where feasible, shall be installed on the sides thereof opposite those sides that face the roadway. Where such installation is not feasible, conduits shall be installed on the quadrant of such standards and poles opposite the quadrant facing the direction of the flow of traffic.

All conduit shall be installed so that the cable or wire will not be injured in pulling.

After installation, the Contractor shall clean out all new and reused conduits by pulling a mandrel or steel brush, approved by the Engineer, through each run. At all stages of the work, everything possible shall be done to prevent foreign material from entering conduits.

All ends of conduit not immediately connected or used shall be capped.

Where basements exist under sidewalks in the path of conduit runs, the Contractor shall notify the owners of the affected buildings and arrange for installing the conduit in each such basement. Conduit placed in basements under sidewalk shall be attached to the street retaining wall of the basement or shall be supported from the sidewalk structure immediately adjacent to the retaining wall as determined by the Engineer. Such conduits shall be securely supported and fastened with conduit straps or galvanized hangers, spaced not more than 5 feet apart. Machine screws and expansion shields in accordance with the requirements of Section 601 shall be used to fasten conduit clamps, straps and hangers to concrete and masonry structures.

Holes drilled for conduit through walls and other structural members adjacent to subsidewalk basements shall be completely sealed around the conduit with a bead of "Sulco", or approved equal, caulking compound and a mixture of cement mortar and "Sulco Grouting Iron", or approved equal, metallic waterproofing compound, in accordance with recommendations of the manufacturer of the caulking and waterproofing compounds.

The use of an impact rotary type drill for drilling holes through

basement walls and sidewalks is prohibited.

After installation, all accessible exposed surfaces of steel conduits in basements shall be painted with one heavy coat of Subox Incorporated, Subalox No. 511, or approved equal, primer, in accordance with the requirements of Section 909. All conduits in basements shall be identified with one-inch high letters stenciled in black paint at intervals of not more than 18 feet.

The installation of service and control conduits into handholes and pull boxes of the Pacific Gas and Electric Company, the Pacific Telephone and Telegraph Company, the Department of Electricity, or other companies or agencies, shall conform to the requirements of the respective companies, or agencies. The Contractor shall contact representatives of these organizations for instructions regarding the locations and the methods of terminating such conduits within the manholes and pull boxes. Where a service connection is made at a manhole, vault or handhole, the conduit shall enter therein just enough so that a bushing may be placed on the conduit end, and the opening around the conduit shall be neatly, carefully, and completely filled with Class "B" mortar.

Conduit installed on steel poles and standards shall be supported by approved one-hole, or other specified, galvanized malleable iron clamps and stainless steel machine screws, spaced not more than 5 feet apart. Both conduit and conduit clamps shall be painted with a heavy prime coat of Subox Incorporated, Subalox No. 511, or approved equal, and finished with two (2) coats of Subox Incorporated, Subalox No. 510 (white metal) or Subox No. 17 (olive green), or approved equal, color as determined by the Engineer. The Contractor shall furnish and install all necessary fittings for attaching the conduit at its entrance to equipment.

When installing conduit in the ground, and under existing pavement or sidewalk, the Contractor shall lay the conduit in open trench. If permitted by the Engineer, the Contractor may install metallic conduit in the ground by opening sections of trench and pushing the conduit from one opening to the next without breaking the surface between openings. The pushing of the metallic conduit shall be done with hand-power jacks or other methods, approved by the Engineer, permitting the application of constant pressure. If jacking of metallic conduit is employed, inspection holes shall be opened, wherever requested by the Engineer, to determine compliance with the requirements for depth and line.

Rigid Metallic Conduit. --Rigid metallic conduit shall not be cut with pipe cutters but shall in all cases be cut with a hack saw. Both ends of every length and piece of conduit shall be carefully reamed open to the full diameter, and all burrs and sharp edges shall be removed. Threads shall be cut clean and true with sharp dies. No connections shall be made with defective threads. No pipe fittings, except caps, shall be used. "Erickson" or OZ two-bolt split type, or approved equal, couplings shall be used at each point of conduit union. All conduit and screwed fittings shall be securely tightened, and all joints shall be watertight.

Except for indoor work in dry locations, the external threads only of all steel conduit and fittings shall be well painted with white or red lead and oil before assembly, so that the lead and oil will not be forced into the conduit in tightening the joints.

The external threads only of all aluminum conduit and fittings shall be coated with a petroleum base lubricant containing powdered zinc before assembly with other aluminum parts; all aluminum conduit threads shall be coated with "Penetrux," or approved equal, sealer and lubricant before joining to metal other than aluminum.

Electrical Metallic Tubing. --Unless otherwise specified, electrical metallic tubing may be used at the following locations only:

- 1) In furred spaces.
- 2) In partitions other than concrete or solid masonry.
- 3) For exposed work above switch height indoors, except on boiler structures, or in refrigerated rooms.
- 4) In hollow concrete block walls, in the vertical cells or horizontal courses not containing steel.

Flexible Conduit. --Unless otherwise specified, the installation of flexible conduit shall be in accordance with the following requirements:

- 1) All flexible conduit installed in outdoor or damp locations and inside refrigerated rooms shall be liquid-tight type.
- 2) Flexible conduit shall be used for connection of all motor terminal boxes to conduit stubs, outlets or junction boxes. Flexible conduit connecting to splash-proof or totally-enclosed motors shall be liquid-tight type, regardless of location. Where motors are mounted on sliding bases, the flexible connection shall be of sufficient length to allow full travel of motor on base.
- 3) For systems higher than 150 volts to ground, continuity of equipment ground shall be obtained either by installing inside the conduit a bonding wire, each end of which shall be bolted to an outlet or junction box by a separate bolt, or by using liquid-tight flexible conduit approved for this purpose.

Rigid Plastic Conduit. --All conduit and fittings shall be designed for solvent-weld joining, providing watertight and vapor-proof connections, and shall be made in accordance with the manufacturer's recommendations, a copy of which the Contractor shall give to the Engineer in the field. All conduit shall be kept clean during construction.

Asbestos-Cement and Fiber Conduit. --The joints in asbestos-cement and fiber conduits shall be made by means of "Harrington" type, or approved equal, couplings. The joints in the asbestos-cement conduit shall be made watertight by the use of Johns-Manville, or other approved asphalt-base sealing compound. The compound shall be applied to the tapered end of the conduit and the coupling forced over it, thus forcing any excess compound away from the inside of the joint instead of into it. No jointing compound shall be used for fiber conduit.

Ends of conduit shall be terminated at pull boxes with a standard transite or fiber end bell, and all open ends of conduit shall be provided with a suitable plug or cap.

In installing transite or fiber conduit without concrete encasement,

trenches shall be carefully excavated and the bottoms thereof made smooth, so that, at all points, the trench bottom will conform accurately to grade and provide uniform support for the conduit.

After the conduits have been aligned, proper fill material shall be placed and carefully and firmly tamped under, around and over them with hand tampers, in accordance with the requirements of Section 603.

Measurement for Payment.--If the Proposal includes a Bid Item or Bid Items specifically for conduit, such conduit will be measured for payment along the actual longitudinal centerline, for each size of conduit.

The quantity to be paid for will be the aggregate length thereof in place, including all fittings and bends in the conduit runs. The length of any fitting connecting sections of conduit of different sizes will be included in the length of the larger size conduit.

If the Proposal includes a Bid Item or Bid Items, other than for conduit, specifically for or specifically including appurtenances such as pull boxes and junction boxes, such appurtenances in the conduit run shall not be included in the aggregate length of the conduit, and the conduit lengths shall be measured to the actual ends of the conduit entering such appurtenances.

If the Proposal does not include a Bid Item or Bid Items, other than for conduit, specifically for or specifically including appurtenances such as pull boxes and junction boxes, no deduction will be made from the aggregate length of conduit because of such appurtenances in the conduit run.

602.04 PULL BOXES AND JUNCTION BOXES.--Pull boxes and junction boxes, if not prefabricated, shall be constructed where and as shown on the plans or specified in the Special Provisions, or where directed by the Engineer. Conduits shall be brought into each box in such manner that sufficient space is allowed for proper bonding of the conduits and so that the wires and cables can be installed without damage.

Street lighting and traffic signal pull boxes shall be George P. Forni, Inc., No. 5 State, or approved equal, prefabricated reinforced concrete pull boxes, each complete with removable reinforced concrete cover and crushed rock pad, as shown on the plans. The maximum size of crushed rock shall be  $3/4$  of an inch in diameter. The reinforced concrete covers shall be George P. Forni, Inc., Type 10D-17, or approved equal, and each shall be inscribed with 2-inch high letters "STREET LIGHTING - HIGH VOLTAGE," "STREET LIGHTING, 120/240 VOLT," or "TRAFFIC SIGNAL," as applicable. Covers for boxes containing high voltage cable shall be provided with two  $3/8$ -inch brass hold-down bolts, brass nuts, and brass washers. The nuts shall be recessed below the surface of the cover. Before installing the cover, the threads of the brass bolts and nuts shall be heavily coated with an approved high graphite content lubricant. Pull boxes shall be installed with covers level with curb or sidewalk grade.

Street lighting and traffic signal junction boxes shall be George P. Forni, Inc., No. 6 State, or approved equal, prefabricated reinforced concrete junction boxes, each furnished and installed complete with

crushed rock pad, inscribed removable reinforced concrete cover and hold-down bolts, as applicable, all as similarly set forth hereinbefore for the No. 5 State pull boxes.

Concrete for site-constructed pull boxes shall be Class "B" as specified in Section 900.11.

After the wires and cables have been installed and the necessary splices and bonding completed, all pull boxes and junction boxes shall be cleaned of dirt and the covers placed.

A concrete slab, 3 feet x 3 feet x  $2\frac{1}{2}$  inches, shall be furnished and installed around each pull and junction box installed in unpaved, rock, and asphalt concrete sidewalk areas.

**602.05 FOUNDATIONS FOR STANDARDS.** --Concrete foundations shall be constructed for traffic signal standards, lighting standards and other standards in accordance with the applicable requirements of Section 900.

Forms, where required, shall be constructed to the full depth of the foundation. Conduit bends and anchor bolts shall be accurately and securely mounted and held firmly in position by approved templates.

After stripping of forms, the backfill shall be compacted until a minimum of 90-percent "Relative Compaction" is achieved. Reference is made to Section 603 for the definition and method of testing "Relative Compaction."

Concrete shall be Class "B" as specified in Section 601.03.

The top surface of the foundations shall be floated and finished to conform to the adjacent sidewalk, or at such other elevation as may be specified or shown on the plans.

Where a standard is to be installed above a subsidewalk basement, the foundation therefor shall be of a design suitable for the particular situation, as approved by the Engineer. Such foundations in subsidewalk basements, including necessary conduit elbows and anchor bolts, will be provided by the Owner of the affected property at no cost to the Contractor, unless otherwise specified.

**602.06 STANDARDS.** --Standards for traffic signals, for traffic safety lights, and for other signal and lighting facilities, shall be furnished and installed on concrete foundations. Concrete foundations shall be in accordance with the requirements of Section 602.05. Standards shall not be erected on the concrete foundations until at least forty-eight (48) hours after placing concrete, and in no case until such erecting has been approved by the Engineer; however, each lighting standard shall be installed no later than five (5) calendar days beginning with and including the starting date of the commencement of excavating for its foundation.

Each standard shall be mounted on the foundation bolts and shall be accurately plumbed and brought to proper grade. Nuts on the bolts shall be set up tight. Standards having a door in the base shall be erected so that the doors will face as shown on the plans, or as directed by the Engineer.

The foundation outside the base of metal standards shall be brought to sidewalk grade and shall pitch away from the shaft. The topping material shall be forced under the bottom of the base casting to give it a

uniform bearing.

Metal standards having bracket arms shall be erected so that the arms are at right angles to the curb, unless otherwise specified.

After each concrete standard has been plumbed upon its foundation, the bottom of the base of the standard shall be given a complete uniform bearing on the foundation by rodding in Class "B" cement mortar. The mortar shall be of the proper consistency to be worked into the complete space between the base of the standard and the foundation, and shall be placed so as to completely cover the foundation bolts.

When a standard is erected in the sidewalk area where no concrete sidewalk exists, the Contractor shall construct one flag of concrete sidewalk around the base at the proper sidewalk grade.

Metal standards shall be furnished with a shop prime coat as specified on the plans or in the Special Provisions. The Contractor shall touch up the prime coat where defective or injured during transportation or installation, and shall allow the paint to dry thoroughly, after which he shall paint each standard with two (2) finish coats. The exposed parts of all luminaires shall be given two (2) finish coats after installation. At the conclusion of painting, all glassware shall be clean, and free of paint.

#### 602.07 WIRE AND CABLE

General. --Wire and cable shall be as shown on the plans or as specified in the Special Provisions.

Wire or cable shall not be kinked, shall be drawn into the conduit and installed without injury to the insulation, and shall not be deformed or otherwise injured before or while being drawn into the conduit or at any other time. All damaged wire or cable shall be immediately and distinctively painted at the point of damage, and the damaged portions shall not be used in the work.

All wires or cables shall be drawn into or out of a conduit at the same time. Lubricants used in drawing wires and cables through conduit shall be "Flax-Soap", or approved equal.

No wire or cable shall be pulled by an automobile or truck, but mechanical devices with quick-release mechanisms may be used if such devices are specifically approved by the Engineer. Cable shall be pulled by means of approved cable grips or "wire baskets".

All wires and cables shall be of sufficient length to provide for slack loops in all pull boxes, condulets, switch enclosures, manholes, bases of standards, and traffic signal controller pedestals. Slack loops shall not be less than 3 feet long in bases of standards and controller pedestals; slack loops shall not be less than 6 feet long in pull boxes, junction boxes, and manholes, unless otherwise directed by the Engineer.

All wires and cables shall be neatly formed and laced together in terminal boxes, control boxes and other enclosures and, whenever there are terminal strips, such enclosures shall be properly and neatly fanned out to the terminals.

In lieu of lacing, the Contractor may use Thomas and Betts Company, Inc., "Ty-Rap" or approved equal, cable ties and straps. Such ties and straps shall be installed on one-inch maximum centers, and shall be in-

stalled with a Thomas and Betts Company, "Ty-Rap" Catalog No. WT 183F, or approved equal, tool.

Terminal lugs for No. 8 and larger conductors shall be Thomas and Betts Company, or approved equal, color-keyed two-hole copper alloy lugs. Splicing connectors for No. 8 and larger conductors shall be Thomas and Betts Company, or approved equal, copper based "C" taps and shall be of the proper size to accommodate the number of conductors being spliced together.

All existing conduits which are to be used shall be carefully cleaned or swabbed out before any wire or cable is installed therein.

The use of split bolt connectors is prohibited.

Traffic Signals.--Intersection and service wires for traffic signal and intersection controllers shall be No. 14 AWG or No. 10 AWG, in accordance with the table that follows, single conductor copper, insulated for 600 volts with 4/64-inch plasticized polyvinyl chloride Type "TW" insulation.

Unless otherwise specified, all wires terminating in a metallic enclosure shall terminate on a terminal board.

Wires not terminating on terminal boards with box type lugs, shall be terminated with Thomas and Betts Company "Sta-kon," or approved equal, terminal lugs and solderless connectors of the proper sizes. Terminal lugs and solderless connectors shall be installed by means of a Thomas and Betts Company "Shure Stake," or approved equal, tool having a pawl arrangement that prevents the jaws of the tool from opening until the terminal lug or connector has been properly staked.

Where intersection wires run through manholes, the wires shall be formed into a cable by taping with Scotch No. 33, or approved equal, and taped and supported to the walls of the manholes by hangers and clamps of an approved type, as shown on the plans.

Unless otherwise noted on the plans or specified in the Special Provisions, the insulation shall be color-coded and the wires installed in accordance with the following table:

Circuit	Phase	AWG		Base Color	Stripe and Tag
		No.			
Vehicle Signals	A	14	Red, Yellow, Green	None	
	B	14	Red, Yellow, Green	White	
	C	14	Red, Yellow, Green	Black	
	D	14	Red, Yellow, Green	White, (Tagged OV)*	
	E	14	Red, Yellow, Green	Black, (Tagged EV)*	
Pedestrian Signals	A	14	"DON'T WALK"-Red	None, (Tagged AP)*	
	A	14	"WALK"-Green	None, (Tagged AP)*	
	B	14	"DON'T WALK"-Red	White, (Tagged BP)*	
	B	14	"WALK"-Green	White, (Tagged BP)*	
	C	14	"DON'T WALK"-Red	Black, (Tagged CP)*	
	C	14	"WALK"-Green	Black, (Tagged CP)*	
	D	14	"DON'T WALK"-Red	White	
	D	14	"WALK"-Green	White, (Tagged DP)*	
	E	14	"DON'T WALK"-Red	Black	
	E	14	"WALK"-Green	Black, (Tagged EP)*	

Circuit	Phase	AWG No.	Base Color	Stripe and Tag
Detectors	A	14	Blue	None
	B	14	Blue	White
	C	14	Blue	(Tagged C)*
Trolley Switches	C	14	Blue	Black, (Tagged TS)*
Pedestrian Pushbuttons	A	14	Blue	None, (Tagged APB)*
	B	14	Blue	White, (Tagged BPB)*
	C	14	Blue	Black, (Tagged CPB)*
	D	14	Blue	White, (Tagged DPB)*
	E	14	Blue	Black, (Tagged CPB)*
Neutral (Trolley Switches)	-	14	White	None
Neutral (Signal Lights & Signs)	-	10	White	None
Neutral (Push- buttons & Detectors)	-	14	White	(Tagged PD)*
Service Wires	-	10	Black	None
	-	10	White	None
Spares	-	14	Black	None

\* Tags shall be made of sheet aluminum or brass, permanently stenciled or marked as indicated, subject to the approval of the Engineer. Tags shall be fastened to the conductors at each point of junction and in all pull boxes.

Where new wiring is installed in the same enclosure with existing wiring and the signal phasing is changed, the Contractor shall remove existing tags that do not comply with the above coding, and shall replace such tags with new tags bearing the correct designations.

Street Lighting.--High voltage street lighting cable shall be No. 8 AWG, single conductor solid copper, insulated for 5,000 volts with color-coded polyvinyl thermoplastic insulating compound 10/64-inch thick. The cable shall conform to the requirements of Section 8.7 of the latest "Specifications for Wire and Cable with Rubber and Rubber Like Insulation," of the Insulated Power Cable Engineers' Association. Factory tests necessary to show complete compliance with IPCEA specifications shall have been made, and certified copies thereof submitted to the Engineer prior to the delivery of the cable. Splices in high voltage cable will be permitted only where approved by the Engineer, and shall be as shown on the plans. Connectors for the high voltage street lighting conductors shall be "Nicopress," or approved equal, installed with a "Nicopress," or approved equal, tool.

Wiring with 600-volt insulation shall be of the sizes shown on the plans or specified in the Special Provisions. Conductors of No. 6 AWG, and larger, shall be stranded. Conductor insulation shall be as shown on the plans or specified in the Special Provisions. Splices in wiring with 600-volt insulation will be permitted only in bases of lighting standards and in pull boxes, and then only with the approval of the Engineer. Such splices, when permitted, shall be in accordance with the applicable details shown on the plans, or as directed by the Engineer.

The insulation for street light wiring shall be color-coded as follows:

<u>Phase</u>	<u>Color</u>
A	Black
B	Red
C	Blue
Neutral	White

**602.08 STREET LIGHTING LUMINAIRES.** -- All luminaires furnished shall be complete with lamps. All sockets shall be adjusted to place the lamp filaments in proper position with respect to the deflectors and globe diffusers. Adjustments shall be made in accordance with the recommendations of the luminaire manufacturer, or as directed by the Engineer.

All plastic and glassware shall be mounted and held firmly in position by attachment devices, which shall be properly adjusted so that temperature changes in the plastic or glass will not develop undue stresses. All light diffusing material shall, at the time of acceptance, be clean and free from paint.

#### **602.09 LIGHTING FIXTURES**

**General.** -- Lighting fixtures shall be furnished and installed in accordance with the following requirements:

- 1) All lighting fixtures furnished and installed shall be complete with lamps.
- 2) All standard fixtures, as specified on the plans or in the Special Provisions, shall be approved by the Underwriter's Laboratories, Inc., and shall have the inspection label attached thereto.
- 3) Where RLM fixtures are specified, they shall have the RLM label attached to each fixture. Attaching of UL or RLM labels after delivery of fixtures will not be acceptable.
- 4) In lieu of the RLM label, a certificate of compliance, with the RLM standards, as determined by an independent testing laboratory, will be acceptable.
- 5) Stems of suspended fixtures shall be so attached that an upward force will not displace them from the hanger.
- 6) Except where conduit stems or rods are specified or shown on the plans, all fixture stems shall be of standard manufacture, factory-finished to match the fixture.
- 7) All ballasts shall be manufactured in accordance with the Certified Ballast Manufacturer's standards, and shall have the CBM label attached.

Substitutions. --If the Contractor desires to substitute lighting fixtures of a manufacturer different from the brand or brands specified, the following procedures and requirements shall be met:

- 1) The City may request a sample of each fixture type proposed as a substitute. Sample fixtures shall be submitted in sufficient time to allow for inspection by the City, without delaying construction.
- 2) Approval will be granted only after the submitted samples are judged equal to those specified. The performance characteristics and construction quality must be substantially equal in the following respects:
  - a) Candlepower distribution.
  - b) Fixture efficiency.
  - c) Brightness and shielding angle in both longitudinal and transverse directions. The data presented shall be certified by an independent test laboratory.
  - d) Finish, including appearance, metal treatment, quality and hardness of paint.
  - e) Quality and gauge of materials.
  - f) Methods of assembly and workmanship.
  - g) Equality of components.
  - h) Ease of installation and maintenance.

602.10 RELOCATING FIRE ALARM AND POLICE TELEPHONE BOXES. --Materials and appurtenances furnished by the Contractor for relocating existing fire alarm boxes and police telephone boxes, and the installation of such materials and appurtenances and other related work, shall be in accordance with the requirements of the Standards of the Department of Electricity.

The Contractor shall not do any work whatever on the existing Municipal fire alarm or police telephone boxes, conduit, wiring, or other elements of these systems, except that specified or shown on the plans in the presence of an authorized representative of the Department of Electricity, who will supervise and inspect the work.

The Department of Electricity shall be notified at least forty-eight (48) hours before any such work is to be started to assure that the aforementioned authorized representative will be on hand.

The work shall consist of removing, furnishing as necessary, and installing, all materials and appurtenances, except wire and cable, necessary to relocate the boxes. Included in such materials and appurtenances are sockets, conduit and fittings, sleeves, and concrete foundations.

The Department of Electricity will furnish and install the Municipal fire alarm boxes and police telephone boxes in the relocated sockets and will furnish, install, connect, and test all wires and cables thereto, all at no cost to the Contractor.

602.11 RELOCATING TRAFFIC SIGNAL, LIGHTING, AND OTHER STANDARDS. --Materials and appurtenances furnished by the Contractor for relocating existing standards supporting traffic signals and controllers, City-owned traffic safety and street lights, and other electrical

facilities, shall be in accordance with the applicable requirements for new installations.

The Contractor shall notify the Engineer at least forty-eight (48) hours in advance of starting work on the existing standards or affected electrical systems.

Each standard with its foundation shall be moved as a unit, or a new foundation shall be constructed and the existing foundation broken up and removed from the site of the work by the Contractor as his property.

Existing conduit shall be relocated, cut off, or otherwise altered, as necessary; conduit, fittings, and appurtenances shall be furnished and installed; and all connections shall be made to extend the existing conduit system to each relocated standard.

New wires and cables shall be installed in each conduit run lengthened by the relocation. Unless otherwise specified on the plans or in the Special Provisions, existing wires and cables not required for the operation of the relocated facilities, or the system or systems of which they are a part, shall be removed from the site of the work by the Contractor as his property.

**602.12 POLE RISERS.**--The Contractor shall furnish and install service pole risers, consisting of conduit and wires or cables, on Pacific Gas and Electric Company poles. Each completed installation shall be in accordance with the requirements of that Company.

Conduit risers shall be galvanized and each shall extend up the pole not less than 8 feet and not more than 10 feet above the ground line or sidewalk grade, as applicable. Conduit above ground shall be fastened to the pole by means of one-hole galvanized malleable conduit clamps and galvanized lag screws. The Contractor shall leave sufficient lengths of wire or cable at the top of each riser he installs to extend up the pole and make the necessary connection to the source of supply. The wood moulding, condulets, clamps, pot-heads, and other appurtenances, necessary to complete each pole riser connection, will be furnished and installed by the Pacific Gas and Electric Company at the expense of the Contractor. The amount of this expense shall be ascertained from said Company by the Bidder, and shall be included by him in his bid price.

**602.13 BONDING AND GROUNDING.**--All steel conduits terminating in manholes, pull boxes, and bases of standards and traffic signal controllers shall be effectively bonded, both together and to exposed metallic surfaces of traffic signal controllers, metal standards and other equipment, by means of grounding bushings, bonding jumpers, grounding "studs" and screw-type pressure solderless lugs, as applicable.

Materials and devices used for bonding and grounding shall be in accordance with the requirements of Section 601.04, and wherever employed in this regard, machine screws, lock washers and nuts shall be stainless steel.

All surfaces to which bonding and grounding materials and devices are fastened shall be cleaned to bright metal before attaching and fastening thereto.

Conduit shall be effectively grounded at the locations shown or specified, and elsewhere as necessary, by means of 5/8-inch copper-clad ground rods, 10 feet long, driven completely into the ground and connected to the conduit by means of ground clamps, grounding connectors, grounding bushings, bonding jumpers, and stainless steel machine screws, lock washers and nuts, as applicable.

At the option of the Contractor, conduit bushings with grounding wedges and lock nuts may be substituted for grounding bushings.

The Contractor shall furnish and apply an anti-oxidant coating on all exposed junctions of bonding and grounding materials.

## **Section 603**

### **Excavating, Backfilling, and Restoring Pavements and Related Improvements**

The Contractor, as Incidental Work, shall do all excavating, backfilling, and restoring of pavements and related improvements necessary, or required, for the proper installation of electrical equipment, conduit, and appurtenances.

Where the existing finished pavement surface is concrete, including concrete parking strip, concrete gutter, and concrete sidewalk, all cuts therein between pavements to be removed and those to remain in place shall be made in accordance with the applicable requirements of Section 201.02.

Trenches and other excavations shall be made safe and passable by the use of barricades, bridges and other approved means, and, unless otherwise allowed, shall have vertical sides.

Conduit buried in ground shall have the applicable minimum cover specified in Section 602.03.

Backfilling shall not commence until after structures, electrical equipment, conduit, and appurtenances have been properly constructed, or furnished and installed, as applicable, and inspected.

Except as otherwise specified, site-excavated materials may be used for all backfill. Backfill shall be free of debris, wood and other organic or deleterious matter.

All backfill other than sand shall be placed in horizontal layers not more than 8 inches thick before compaction, and each layer shall be satisfactorily compacted by mechanical means. Sand backfill shall be flooded or jetted, or compacted by other approved means, in horizontal layers not more than 3 feet thick.

All backfill in roadway areas shall be compacted to a minimum relative compaction of 90 percent. All other backfill shall be compacted to a relative compaction matching that of the existing adjacent ground.

The term "Relative Compaction" means the percentage ratio of the field-compacted dry density to the maximum dry density obtainable by compaction at optimum moisture content.

## Section 604

The methods of testing compaction, including determination of optimum moisture content and maximum density, shall be in accordance with ASTM "Standard Methods of Test for Moisture-Density Relations of Soils, Using a 10-lb. Rammer and an 18-in. Drop," Designation D 1557.

Compaction tests, as required by the Engineer, on the particular material used will be conducted and evaluated by the City at no cost to the Contractor.

Pavements and related improvements shall be restored in accordance with the requirements of Section 108.09, and construction thereof shall be accordance with the applicable requirements of PART II of these Standard Specifications.

## **Section 604**

### **Payment**

Electrical work, satisfactorily constructed or furnished and installed as specified, will be paid for at the lump sum price bid therefor, except as otherwise specified herein or in the Special Provisions.

## **PART VII**

# **AUXILIARY WATER SUPPLY SYSTEM FOR FIRE PROTECTION**

### **Section 700**

#### **General Requirements**

**700.01 QUALITY OF MATERIALS AND WORKMANSHIP.** -- All materials shall be free from defects throughout their mass, and shall be of uniform high quality.

All castings shall conform to the shapes and dimensions shown on the plans and shall be made in such molds and with such cores as will render the castings clean, smooth, and free from undue cooling strains. Castings shall remain in the flasks a sufficient length of time to prevent unequal contraction in cooling.

The castings shall be true to patterns, sound, smooth and free from all flaws, defects or imperfections of any kind which, in the judgment of the Engineer, render them unfit for the use for which they are intended. All projections resulting from gates or risers shall be cut off and ground smooth with the surface of the casting.

No plugging, filling or welding of defects in castings will be allowed, except in the case of cast steel castings if specifically approved by the Engineer.

All machined surfaces shall be true and smooth and the parts containing such surfaces shall be finished to conform to gauges, templates or jigs, so that all parts will be interchangeable.

**700.02 GUARANTEE OF CASTINGS.** -- The Contractor shall furnish the Engineer with six (6) copies of a guarantee certifying that the manufacturer has fabricated the castings in conformity with all applicable provisions of the ASTM and ASA Specifications, and that the dimensions and details of the castings comply with the plans and specifications.

**700.03 FIRE DEPARTMENT JURISDICTION.** -- The existing Auxiliary Water Supply System for Fire Protection is under jurisdiction of the San Francisco Fire Department.

The Contractor shall not operate any valves, hydrants or other control facilities of the Auxiliary Water Supply System. Such operations shall be performed only by members of the San Francisco High Pressure Crew.

The Contractor shall not make any connection to, or otherwise interfere with any part or appurtenance of the Auxiliary Water Supply System, except under the supervision and in the presence of a representative of the Fire Department.

The Contractor shall notify the San Francisco Fire Department at least one (1) week in advance of the date on which he proposes to interrupt service to any portion of the system.

The Contractor shall so conduct his operations that at no time shall more than two adjacent high pressure hydrants be out of service along the line of the work, unless otherwise authorized by the Fire Department.

700.04 INTERRUPTION OF SERVICE TO FIRE PROTECTION SYSTEM TO BE KEPT TO A MINIMUM. -- In the interest of public safety, it is essential that the period of interruption of service to any portion of the Auxiliary Water Supply System pipeline for fire protection service be kept, by proper planning and preparation and expeditious work, to the practicable minimum as hereinafter specified.

It is understood and agreed, therefore, that the Contractor, before any such interruption, shall have on hand at the site all labor, materials, equipment and tools necessary in the opinion of the Engineer for the satisfactory completion of all the work, including testing and back-filling, necessary, or required, to restore the fire protection system to service, all where and as shown on the plans and in accordance with the Special Provisions.

Once the Contractor begins work on the AWSS pipeline, he shall continuously prosecute all such work to completion, including placing the line in service.

700.05 ENGINEER TO BE NOTIFIED. -- The Contractor shall notify the Engineer forty-eight (48) hours in advance of the day that the opening or closing of any AWSS valve is required.

700.06 WORK TO BE COMPLETE. -- The Contractor shall do all work and furnish and install all appurtenances and materials, other than those furnished by the City, or removed by the Contractor, which are necessary, or required, to complete the work, such as bolts, nuts, washers, lead, yarn, paint, machine oil, graphite, concrete thrust blocks, bracing, brackets, hangers, clamps, inserts, gaskets, etc., in accordance with applicable sections of these Standard Specifications, whether or not specified or shown on the plans or specified in the Special Provisions, and the cost thereof shall be included in the price or prices bid.

## Section 701

### Ductile Cast Iron Pipe

New ductile cast iron pipe shall conform to the requirements set forth on the plans and in the Special Provisions. Existing gray cast iron pipe shall be reused only when specifically designated for such reuse on the plans or in the Special Provisions.

## Section 702

### Gray Cast Iron Special Castings

702.01 GENERAL. --The castings covered in this Section are of City design, and include sleeves, caps, plugs, offsets, line reducers, valve reducers, hydrant tees, blow-off tees, Type 1 bell and spigot elbows, Type 3 double spigot elbows, fire boat wharf manifolds, and other special castings. All castings shall be in strict accordance with the plans, or samples provided by the City.

702.02 CAST IRON. --Cast iron shall be in accordance with the requirements for Class "A" of ASTM "Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings," Designation A 126.

702.03 TESTS AND TEST SPECIMENS. --Test specimens, as required by the ASTM Specifications, shall be furnished by the Contractor, at his own expense, to the Engineer for testing by the City.

702.04 ALLOWABLE VARIATIONS IN DIMENSIONS AND WEIGHT Gauges. --The Contractor shall furnish all the necessary tolerance gauges and any other gauges which may be required by the Engineer to check the dimensions of the castings for conformity with the plans and the allowable tolerances.

Diameters. --The inside diameters of the bells and the outside diameters of the spigot ends shall not vary from the standard dimensions by more than 0.10 of an inch for nominal diameters of 14 inches or less; and by 0.12 of an inch for nominal diameters larger than 14 inches.

Depth of Bell. --The depth of bell shown on the standard or detail plans shall be the minimum with a plus tolerance not to exceed 0.10 of an inch.

Thickness. --For castings whose standard thickness is less than one

inch, the thickness of metal shall not be more than 0.12 of an inch less than the standard thickness. For castings whose standard thickness is one inch or more, the variation shall not exceed 0.15 of an inch.

Weight.--No casting will be accepted which weighs less than 92 per cent of the Standard Weight. For any individual casting, when payment under the contract is by weight, no payment will be made for weight in excess of 8 percent above Standard Weight, and for the total number of castings, no payment will be made for weight in excess of 4 percent above the sum of the Standard Weights. The Standard Weight will be computed by the Engineer from the standard plans, assuming cast iron to weigh 0.2604 pounds per cubic inch.

702.05 MARKING CASTINGS.--Every casting shall have distinctly cast upon the outside surface in raised letters, not less than 1½ inches in length and 1/8 inch in relief: AWSS, the nominal diameter, and the class. For example: AWSS 12" x 10" GH.

The letters shall be arranged in a manner satisfactory to the Engineer. In the case of elbows, the amount of bend shall also be indicated as required hereinbefore.

Letters and figures for marking castings shall be cast more than 12 inches from any spigot end.

In case any castings shall be rejected, the letters AWSS shall be erased by the Contractor under the supervision of the Engineer.

702.06 HYDROSTATIC TEST.--The castings shall be subjected to a hydrostatic test pressure for a period of not less than four (4) minutes. The castings shall be subjected to a hammer test while under pressure. The following hydrostatic pressures will be used in testing the different classes of cast iron specials.

<u>Class</u>	<u>Test Pressure in Pounds per Square Inch</u>
A-B Specials . . . . .	450
C-D Specials . . . . .	600
E-F Specials . . . . .	800
G-H Specials . . . . .	1000
Manifolds . . . . .	1000

Any casting which shows any defect by leaking or sweating, which cannot be stopped by peining, will be rejected.

702.07 COATING.--After testing, every casting shall be cleaned and then coated inside and outside with coal tar pitch varnish. To this material sufficient oil shall be added to make, when cold, a coating, smooth, tough, and not brittle nor with a tendency to scale off, and of sufficient thickness to not scrape off in handling.

Each piece of pipe or casting shall be heated to a temperature of 300 degrees Fahrenheit immediately before it is dipped, and shall possess not less than that temperature at the time it is put in the vat. The ovens in which pipe and castings are heated shall be arranged so that all portions thereof shall be evenly heated to the specified temperature.

The varnish shall be heated to a temperature of 300 degrees Fahrenheit and shall be maintained at this temperature during the time the pipe or casting is immersed. Each pipe or casting shall remain in the bath at least fifteen (15) minutes.

Fresh pitch and oil shall be added to keep the mixture at the proper consistency, and if necessary the vat shall be emptied of its contents and refilled with fresh pitch. After being coated, each pipe and casting shall be carefully drained of surplus varnish. When hardened, the coating shall be free from blisters and bubbles. Blisters, bubbles and other coating defects shall be removed before required recoating.

The aforementioned coating shall not be damaged, the pipes and castings shall be handled carefully, and no pipe or other material of any kind shall be placed in pipes during transportation or at any time after they have been coated.

**702.08 CASTINGS TO BE WEIGHED.** --After the coating has hardened, the castings shall be weighed at the place of manufacture, under the supervision of the Engineer, on correct scales provided by the Contractor and tested with U.S. Standard Weights whenever required by the Engineer. The weight and class letter for each casting shall be distinctly marked on the inside of the casting with white paint.

## Section 703

### Cast Steel Special Castings

**703.01 GENERAL.** --The steel castings covered in this Section are of City design, and include sleeves, crosses, tees, valve reducers, Type 2 double bell elbows, equalizer rings, strongbacks, and other Special castings. All castings shall be in strict accordance with the plans, or samples provided by the City.

Before being coated, as required in Section 703.06, all the castings shall be subjected to a hydrostatic test pressure for a period of not less than four (4) minutes. The castings shall be subjected to a hammer test while under pressure. The following hydrostatic pressures will be used in testing the different classes of cast steel specials.

<u>Class</u>	<u>Test Pressure</u>
E-F Specials . . . . .	800 lbs. per sq. inch
G-H Specials . . . . .	1000 lbs. per sq. inch

Any casting which shows any defect by leaking or sweating, which cannot be stopped by peining, will be rejected.

**703.02 CAST STEEL.** --Cast Steel shall be in accordance with the requirements for Grade 70-36 of ASTM "Standard Specifications for Mild

to Medium Strength Carbon-Steel Castings for General Application," Designation A 27.

703.03 TESTS AND TEST SPECIMENS.--Test specimens, as required by the ASTM Specifications, shall be furnished by the Contractor, at his own expense, to the Engineer for testing by the City.

703.04 ALLOWABLE VARIATIONS IN DIMENSIONS AND WEIGHT  
Gauges.--The Contractor shall furnish all the necessary tolerance gauges and any other gauges which may be required by the Engineer to check the dimensions of the castings for conformity with the plans and the allowable tolerances.

Diameters.--The inside diameters of the bells and the outside diameters of the spigot ends shall not vary from the standard dimensions by more than 0.06 of an inch for nominal diameters of 16 inches or less; and by 0.08 of an inch for nominal diameters larger than 16 inches.

Depth of Bell.--The depth of bell shown on the standard or detail plans shall be the minimum with a plus tolerance not to exceed 0.10 of an inch.

Thickness.--The thickness of metal shall not be more than 1/16 inch less than, or 1/8 inch more than, the dimensions shown on the plans.

Weight.--No casting will be accepted which weighs less than 95 percent of the Standard Weight. For any individual casting, when payment under the contract is by weight, no payment will be made for weight in excess of 5 percent above Standard Weight, and for the total number of castings, no payment will be made for weight in excess of 3 percent above the sum of the Standard Weights. The Standard Weight will be computed by the Engineer from the standard plans, assuming cast steel to weigh 0.2836 pounds per cubic inch.

703.05 MARKING CASTINGS.--Every casting shall have distinctly cast upon the outside surface in raised letters, not less than 1½ inches in length and 1/8 inch in relief: AWSS, the nominal diameter, and the class. For example: AWSS 12" x 10" G.H.

The letters shall be arranged in a manner satisfactory to the Engineer. In the case of elbows, the amount of bend shall also be indicated as required hereinbefore.

Letters and figures for marking castings shall be cast more than 12 inches from any spigot end.

In case any casting shall be rejected the letters AWSS shall be erased by the Contractor under the supervision of the Engineer.

703.06 COATING.--After testing, every casting shall be thoroughly cleaned and shall then be coated inside and outside in the manner specified in Section 702.07 for gray cast iron special castings, all the requirements of which shall apply.

703.07 CASTINGS TO BE WEIGHED.--After the coating has hardened, the castings shall be weighed at the place of manufacture, under

the supervision of the Engineer, on correct scales provided by the Contractor and tested with U.S. Standard Weights whenever required by the Engineer. The weight and class letter for each casting shall be distinctly marked on the inside of the casting with white paint.

## Section 704

### Gate Valves

**704.01 GENERAL.** --Gate valves shall be in accordance with the requirements of the Special Provisions and shall comply with the provisions set forth herein.

The gate valve internal mechanism shall consist of a non-rising stem, 2 discs, and inclined faced upper and lower wedges. The discs shall be duplicates so that right and left hand discs are not required.

By action of the stem, the discs shall descend between the guides cast in the body parallel to the seats. The continuing downward movement of the upper wedge moving across the lower wedge shall bring pressure to bear on the backs of both discs thus forcing them squarely against their seats. There shall be no spreading or wedging of the discs until they are opposite the port openings.

The first turn of the stem shall release the seating forces prior to any movement of the discs by separating the upper wedge from contact with the lower wedge.

The body and bonnet of the valve shall be cast iron and shall have well distributed and heavy metal sections.

The body of the valve shall be marked with the diameter of the valve, service rating and manufacturer's name.

The valve stem, seat rings, disc faces and operating nut shall be of cast bronze.

Bolts, nuts and studs shall be of steel.

Flanges shall be faced, drilled and have a raised face of  $\frac{1}{4}$  inch.

All flanges and collars shall be provided with well rounded fillets.

All bolt holes shall be accurately drilled to templates or jigs and spaced equally distant. Bolt holes shall not be cored.

Each valve shall be equipped with a cast bronze operating nut.

Inside and outside surfaces of all iron castings shall be painted with three (3) coats of coal tar pitch-varnish.

**704.02 MANUFACTURER'S GUARANTEE REQUIRED.** --The Contractor shall furnish six (6) copies of a written guarantee from the gate valve manufacturer stating:

- 1) That all materials of the component parts of the valve are equal to:

ASTM A 126 Class "B", for iron castings.

ASTM B 61, for bronze castings.

ASTM A 307 Grade "B", for steel.

- 2) That each valve has successfully passed the following two pressure tests:

Test No. 1

The gate valve bodies and bonnets were subjected to a cold water pressure of 1600 pounds per square inch for a period of not less than four (4) minutes and, while under pressure, did not show any leakage, sweating of water, or other defects.

Test No. 2

After assembly, each gate valve was tested for tightness of the joint between the faces of the discs and its seat by closing the gate, leaving one end of the valve open to the atmosphere and applying cold water hydrostatic pressure of 800 pounds per square inch to the other side of the valve. The gate valve did not show leakage in excess of one (1) fluid ounce per minute, sweating of metal, or other defects.

- 3) That the valve is suitable for service in the service rating of 800 p.s.i.g., non-shock, cold water, oil and gas.
- 4) That if the valve or its component parts should fail in normal service as a result of a defect in workmanship or materials, such defective part or parts will be replaced by the manufacturer, including all shipping, at no cost to the City.

## **Section 705**

### **Castings for Valve Vaults and Valve Boxes**

705.01 GENERAL.--Cast iron frames, covers, and dust pans for valve box assemblies and valve vaults, shields for sewer cross-overs, and other special castings shall be the City's design shown on the plans.

705.02 CAST IRON.--Cast iron shall be in accordance with the requirements for Class "A" ASTM "Standard Specifications for Gray Iron Castings for Valves, Flanges and Pipe Fittings," Designation A 126.

705.03 TESTS AND TEST SPECIMENS.--Test specimens, as required by the ASTM Specifications, shall be furnished by the Contractor, at his own expense, to the Engineer for testing by the City.

705.04 ALLOWABLE VARIATIONS IN WEIGHT.--No casting will be accepted which weighs less than 92 percent of the Standard Weight. For any individual casting, when payment under the contract is by weight, no payment will be made for weight in excess of 8 percent above Standard weight, and for total number of castings, no payment will be made for weight in excess of 4 percent above the sum of the Standard Weights. The Standard Weight will be computed by the Engineer from the standard plans, assuming cast iron to weigh 0.2604 pounds per cubic inch.

The bearing surfaces of the frames and covers shall be finished and perfectly true, and interchangeable in position and with each other.

705.05 CASTINGS TO BE WEIGHED. --All castings shall be weighed at the place of manufacture, under the supervision of the Engineer, on correct scales provided by the Contractor and tested with U.S. Standard Weights whenever required by the Engineer. Each casting shall have its weight indicated thereon in white paint.

## **Section 706**

### **Bolts, Tie Rods and Other Connecting Devices**

706.01 GENERAL. --The Contractor shall furnish and install all bolts, tie rods, nuts, sleeve nuts, washers and other connecting devices necessary for the bolting together of pipe joints and other connections and parts of pipe lines. Such devices shall conform to the standard plans, except that special lengths may be required by the Engineer.

All washers shall be perfectly flat and true to required dimensions, and all nuts and bolts shall have their bearing surfaces smooth and at right angles to the axis of the thread.

All threads shall be thoroughly coated with lubricating oil to which has been added flake graphite in the amount of one (1) ounce per quart of oil.

706.02 MATERIAL. --All of the connecting devices described hereinbefore shall be of wrought iron in accordance with the requirements for Class "B" of ASTM "Standard Specifications for Single and Double Refined Wrought Iron Bars," Designation A 189.

706.03 WIRE BINDERS. --Wire binders where required for the purpose of holding bolts and rods firmly in place in the lugs, shall be furnished and installed by the Contractor. They shall consist of 3 turns of No. 10 BWG soft iron wire, wrapped tightly around the entire set of bolts or rods, with the ends twisted tightly together.

For each set of bolts or rods less than 24 inches in length, one binder will be required.

For each set of bolts or rods 24 inches or more in length, two binders will be required when used in open lugged devices, each binder being placed as close to lugs as possible.

706.04 PAINTING. --After installation, all the bolts, nuts, and other connecting devices shall be painted with two (2) coats of an approved coal tar base paint applied in accordance with the applicable requirements of Section 909.

## Section 707

### Pig Lead and Yarn

707.01 PIG LEAD.—Lead shall be in accordance with the requirements for Common Desilvered Lead of ASTM "Standard Specifications for Pig Lead," Designation B 29.

707.02 YARN.—Yarn used for joint packing shall be braided or twisted jute packing yarn, uniform, best quality, free from tar.

## Section 708

### Radiographic Inspection

When steel castings are specified to be radiographically inspected, the Contractor shall make gamma-ray, or 250 kv (or greater) X-Ray, radiographs of complete castings, or any portion thereof, as selected by the Engineer or his authorized representative. The total number of standard 14-inch x 17-inch radiographic films to be utilized, however, will not exceed 20. Radiographs resulting from such examination shall be properly exposed and easily readable films. Any faulty, underdeveloped, overdeveloped, or excessively foggy films shall be rejected and replacement films shall be exposed, developed and resubmitted for evaluation at no additional cost to the City. All inspection shall be made in accordance with ASTM "Recommended Practice for Radiographic Testing," Designation E 94.

The quality of such steel castings shall be evaluated by comparing the radiographs of each casting with the standard plates comprising the "Gamma-Ray Radiographic Standards," described in ASTM "Industrial Radiographic Standards for Steel Castings," Designation E 71. Said standard plates will be furnished free of charge to the Contractor by the City.

This comparison shall be made on the basis of either "Class 2," or "Class 3," whichever is indicated on the Standard Plan of the particular casting being examined. The radiographs and standard plates shall be compared in the presence of the Engineer or his authorized representative, and any casting which, in his opinion, is not acceptable in Groups "A" through "G", inclusive, of such standards, will be rejected, and the repair thereof by any means whatsoever will not be permitted.

Except for the hereinbefore specified standard plates, the Contractor shall furnish all labor, materials and facilities required for the specified radiographic inspection of the steel castings, and shall include in his bid prices the entire cost, except the wages of the Engineer, of making such inspection.

## Section 709

### Installation of Facilities

709.01 GENERAL.—The Contractor shall lay pipe, fittings, and appurtenances where and as specified in the Special Provisions or shown on the plans, or where directed by the Engineer.

709.02 PIPE YARD.—AWSS materials are stored at the Pipe Yard located at 2245 Jerrold Avenue. Except on Saturdays, Sundays and legal holidays, the yard will be open for receiving or delivering materials during the periods 8:00 a.m. to 12:00 Noon and 1:00 p.m. to 5:00 p.m.

709.03 CONTRACTOR TO HAUL PIPE AND MATERIALS FURNISHED BY CITY.—All pipe, valves, hydrants and other appurtenances and materials furnished by the City to the Contractor for use in the work, shall be handled, loaded, and hauled by the Contractor from the Pipe Yard or other location within the City limits to the site of the work.

709.04 CONTRACTOR'S RESPONSIBILITY FOR CITY-FURNISHED MATERIALS.—The Contractor shall carefully inspect all materials and appurtenances delivered to him by the City and shall not accept any materials or appurtenances that are cracked, broken or defective in any way. The Contractor shall be responsible for all materials and appurtenances delivered to him by the City, and should any materials or appurtenances, in the judgment of the Engineer, be damaged after they are delivered to the Contractor, they shall be promptly replaced with new materials or appurtenances by the Contractor at his sole expense. Failure to so replace such damaged materials or appurtenances will be cause for replacement by the City and all expense of such replacement will be deducted from moneys due the Contractor.

709.05 CONTRACTOR TO RETURN PIPE AND MATERIALS TO PIPE YARD.—All surplus pipe, valves, hydrants, appurtenances and materials, salvaged or otherwise, not used in the work nor specified to be abandoned, and all patterns, that are or become the property of the City, shall be loaded and hauled by the Contractor to the Pipe Yard or other designated location within the City limits, and there placed by him where directed. The Contractor will be issued a receipt for said materials.

709.06 EXCAVATING AND LAGGING.—Excavating and lagging shall be in accordance with the applicable requirements of Sections 300 and 301, except as otherwise specified hereinafter.

All abandoned structures shall be removed to a depth of not less than one foot below the bottom of the required construction. Moreover, in order to allow sufficient space for making joints, the clearance between any joint in the high pressure pipeline installed and any structure or other interference shall be not less than 18 inches.

709.07 SALVAGING AND CLEANING PIPE AND APPURTENANCES.

--The Contractor shall salvage, as the property of the City, and shall clean, all pipe, nipples, fittings, hydrants, valves, and all other appurtenances, that he disconnects from the existing Auxiliary Water Supply System, whether such pipe and appurtenances are reused in the work, or are hauled to the Pipe Yard.

All salvaged pipe and special castings shall be thoroughly cleaned, both inside and outside by sandblasting, of all dirt, rust, scale, and loose paint. After cleaning, the pipe shall be painted both inside and outside with one (1) coat of coal tar pitch varnish.

Exterior iron surfaces of any hydrant or valve to be salvaged shall be cleaned by sandblasting and the interior washed with clean water. After all cleaning has been completed, the Fire Department shall be given the opportunity to inspect, overhaul or repair, as necessary each such hydrant or valve.

After the Fire Department completes work on the hydrant or valve, the exterior surfaces to be installed underground, of the hydrant, and the exterior surfaces of the valve, shall be painted with one (1) coat of coal tar pitch varnish. The exterior surfaces of the hydrant to be installed above ground shall be painted prior to the hydrostatic field test with three (3) prime coats of approved red lead paint, and after satisfactory completion of the hydrostatic field test, with two (2) finish coats of approved high gloss enamel, all in accordance with the applicable requirements of Section 909.

Materials to be returned to the San Francisco Fire Department Pipe Yard at 2245 Jerrold Avenue shall be completely disconnected, cleaned, and painted as specified herein, before being delivered to the Pipe Yard and placed where directed by the Engineer.

Salvaged bolting materials shall not be reused in the work. Lead melted from existing joints shall be salvaged as the property of the City, but shall not be reused in the work.

Immediately prior to installation, to prevent the entrance of any foreign matter into the lines, all pipes, valves, hydrants, other castings, and appurtenances shall be cleaned by the Contractor by brushing and washing, and all dirt and other foreign matter removed.

As the pipe laying proceeds, a proper mandrel, provided by the Contractor, shall be drawn forward as each pipe or special casting is laid. All branches or other openings shall be protected by turning wooden plugs or heads until permanent connections are made. During the progress of the work the lines shall be kept thoroughly clean throughout, and at the conclusion of the work, left clean. Any obstruction or deposit discovered in the lines during inspection of the work shall be removed at once by the Contractor.

709.08 INSTALLATION OF HYDRANTS. --The Contractor shall install hydrants where shown on the plans, or where directed by the Engineer.

Each hydrant shall be carefully examined, the elbow and foot valve thoroughly cleaned, and all dirt and other foreign matter removed, before setting the hydrant in place.

Hydrants shall be set exactly plumb, and at the proper elevation, each on a block of reinforced concrete, or in a vault recess, as shown on the plans.

In compacting backfill around hydrants, they shall be kept plumb, and adequate support to prevent future movement shall be provided. Any hydrant which is out of plumb or not firmly supported, shall be properly reset by the Contractor at his sole expense.

709.09 INSTALLATION OF VALVES. --The Contractor shall install valves in the line, each complete with valve box assembly or valve vault, as applicable, where shown on the plans, or where directed by the Engineer.

709.10 AIR VALVE ASSEMBLIES. --The Contractor shall tap the line and shall furnish and install air valve assemblies, each complete with valve, riser, and valve box assembly, where shown on the plans, or where directed by the Engineer.

709.11 VALVE BOX ASSEMBLIES. --The Contractor shall furnish and construct valve box assemblies over all air valves, 8-inch valves, and 10-inch valves. Each valve box assembly shall be complete with a cast iron cover, dust pan, and frame set in a reinforced concrete block, and shall include a cast iron valve box unless otherwise specified or shown on the plans, and a cast iron pipe casing riser extending from the valve box or valve, as applicable, to the reinforced concrete block, all where and as shown on the plans, or where directed by the Engineer. In the case of air valves and 8-inch valves, unless otherwise specified or shown on the plans, no cast iron valve box will be required and the cast iron casing shall extend from the backfilled material to the concrete box.

Valve box assemblies shall be constructed true and plumb, and cast iron frames and covers shall be set to the pavement surface. The backfilled material shall be satisfactorily compacted in place before the concrete block is constructed thereon.

709.12 VALVE VAULTS. --The Contractor shall furnish all materials for, and shall construct, reinforced concrete valve vaults, each complete with a cast iron frame, cover and dust pan, for all 12-inch, or larger, valves, where shown on the plans, or where directed by the Engineer.

Valve boxes shall be constructed water tight, and cast iron frames and covers shall be set to the pavement surface in such manner that the length of the lifting handles will be in the direction of vehicular traffic flow.

709.13 BOLTING DEVICES. --All bolting devices shall be brought to a snug fit against the lugs but shall have no excessive tension applied. The Contractor may use the bolting devices as a means of homing the pipe or fitting but shall remove all excessive tension from the bolts and return them to a snug bearing before the hydrostatic field test.

709.14 THRUST BLOCKS. --All bends, offsets, dead ends, hydrant tees, and crosses with plugged outlet, shall be braced with wedge shaped concrete anchor blocks, the volume of each of which shall be 6 to 12 cubic feet. The blocks shall be of Class "B" concrete, of such size as the Engineer may direct, and shall be poured against undisturbed ground in the bottom and side of trench. The backfill around the blocks shall be thoroughly tamped.

709.15 BACKFILLING. --Backfilling shall be in accordance with the requirements of Section 304, except that sand shall be placed to at least one foot above the top of the pipe and to a depth 4 inches below the line of the bells of the pipe.

All excavated materials not suitable for backfilling and all surplus excavated materials shall be removed from the site by the Contractor as his property.

709.16 RESTORATION OF PAVEMENTS AND RELATED IMPROVEMENTS. --Pavements and related improvements shall be restored in accordance with the requirements of Section 108.09, and construction thereof shall be in accordance with the requirements of PART II of these Standard Specifications.

709.17 UTILITY CROSSINGS. --In crossing any existing utility, the clearance between the AWSS pipe, fitting or appurtenance, as the case may be, and the utility, shall not be less than 6 inches. Moreover, the clearance between any AWSS joint installed and any utility facility shall be not less than 18 inches.

709.18 HYDROSTATIC FIELD TESTS AND PERMISSABLE LEAKAGE. --Installed pipes and appurtenances shall be tested hydrostatically after installation, but before the joints are backfilled, at the pressure specified in the Special Provisions.

The tests shall be made between plugs or valves in the main line and shall include the hydrant branches either up to the 8-inch valve or to the foot valve of the hydrant, as the Engineer may direct. Where the main line test extends only to the valve on a hydrant branch, the portion of the 8-inch pipe between the valve and the hydrant shall be separately tested.

The Contractor shall furnish all the labor and materials necessary to make the tests and to perform any work incidental thereto. The trench between joints shall be partially backfilled before making tests.

Prior to the hydrostatic field test periods, the Contractor shall furnish and install, as directed, suitable temporary thrust blocks and other anchorages to prevent any movement whatever of the AWSS pipeline and appurtenances during the hydrostatic field tests.

The hydrostatic field tests shall be conducted by the Contractor in the presence of the Engineer, who shall be notified by the Contractor at least forty-eight (48) hours in advance thereof.

The sections of pipes and appurtenances to be tested shall be completely filled with fresh water at line pressure of the respective AWSS

pressure zone in which the work is being done, which pressure shall be maintained for a period of not less than sixteen (16) hours. At the end of the period, the hydrostatic pressure shall be increased to the pressure required for the class of pipe installed, as specified. The Fire Department, at no cost to the Contractor, will increase the hydrostatic pressure to the test pressure hereinbefore specified. It shall be the Contractor's responsibility to provide connections and appurtenances for supplying water and applying hydrostatic test pressure for sections of pipe and appurtenances which are to be tested and are not connected to an existing Auxiliary Water Supply System.

The Contractor shall take all necessary precautions to prevent any joints drawing while pipe and appurtenances are being tested, and he shall, at his own expense, repair any damage to the pipe and appurtenances, or any other structures resulting from or caused by the tests.

No visible leakage will be allowed for each section tested under the pressures specified. If visible leakage occurs, the Contractor shall remake the joints and replace the defective work until the leakage is eliminated.

## Section 710

### Installation of Ductile Cast Iron Pipe and Fittings

710.01 CUTTING AND MARKING PIPES AND NIPPLES. -- All cutting of pipes or nipples, except the cutting of pipe risers for valve boxes, shall be done with a machine which, in the judgment of the Engineer, is suitable for this purpose. The cut ends of the pipe or nipples shall be clean and straight, made at 90 degrees with the longitudinal axis of the pipe.

Every reusable nipple cut from a longer piece of pipe shall have painted thereon with yellow paint the word "DUCTILE".

The cutting of all pipe and nipples shall be considered Incidental Work. All measurements for nipple lengths shall be the responsibility of the Contractor.

Closing nipples shall be cut to exact length, with a minus tolerance only, not to exceed 1/4 inch.

Cut pipe and nipples, other than closing nipples, shall, unless otherwise designated on the plans, be cut to a plus-minus tolerance of one inch.

Under no circumstances will jacking of the pipe be permitted in order to comply with proper length requirements. A realignment in plan or elevation to comply to the length requirements is also prohibited, unless approved in writing by the Engineer.

710.02 MAKING OF JOINTS - MECHANICAL JOINTS AND FLEXIBLE COUPLINGS. --The Contractor shall make all joints in accordance with the following requirements:

The ends of all machined pipe and nipples, including gaskets, shall be lubricated with a soap and water solution or other approved lubricant to facilitate the making of tight joints. The gland shall be tightened evenly with a torque wrench by partially tightening the bolts diametrically opposite until the gasket is fully seated. The torque obtained in tightening the bolts of the gland shall not be less than 40 foot pounds and not more than 60 foot pounds.

## **Section 711**

### **Installation of Gray Cast Iron Pipe and Fittings**

711.01 CUTTING AND MARKING PIPES AND NIPPLES. -- All cutting and grooving of pipes or nipples, except the cutting of pipe risers for valve boxes, shall be done in a machine shop with a machine which, in the judgment of the Engineer, is suitable for this purpose. The cut ends of the pipe or nipples shall be clean and straight and the cut grooves shall conform with the plans as to shape, size and location.

Every reusable nipple cut from a longer piece of pipe shall have painted thereon with yellow paint the size and class of the original full length of pipe, for example:

10" - A

The length of pipe from which the nipples have been cut, shall, if the original cast on letter has been destroyed, also have the size and class painted on the outside of the pipe and also on the inside near the spigot end.

The cutting, grooving, machining, and cartage of all pipe and nipples shall be considered Incidental Work. Such cutting and grooving shall be made at 90 degrees with the longitudinal axis of the pipe. All measurements for nipple lengths shall be the responsibility of the Contractor.

All cut ends of the pipe shall be grooved except when the remaining cut pipe is less than the Standard minimum nipple length.

Closing nipples shall be cut to exact length, with a minus tolerance only, not to exceed 1/4 inch.

Cut pipe and nipples, other than closing nipples, shall, unless otherwise designated on the plans, be cut to a plus-minus tolerance of one inch.

Under no circumstances will jacking of the pipe be permitted in order to comply with proper length requirements. A realignment in plan or elevation to comply to the length requirements is also prohibited, unless approved in writing by the Engineer.

The City reserves the right to furnish pipe for nipples, when available, in approximate lengths, at no cost to the Contractor, from the Maintenance Yard at 2245 Jerrold Avenue.

711.02 MAKING OF JOINTS - GENERAL. --The Contractor shall make all lead joints in accordance with the requirements set forth in Sections 711.03 through 711.07, as applicable.

711.03 BELL AND SPIGOT JOINTS. --The spigot end of the pipe or special casting shall be inserted into the bell the full depth of the bell, and the spigot adjusted in the bell so as to give a uniform space for the joint, which shall be made up of lead and yarn as specified in Section 707. The packing shall be thoroughly and evenly packed into the bell, filling it tightly for a depth of one inch. The remaining space shall then be filled with lead, a bead being left on the outside of the face of the bell sufficient to allow for caulking so that when the joint is properly caulked the lead will be flush with the face of the bell. The use of cold plugs will not be allowed.

711.04 DOUBLE SPIGOT JOINTS. --In laying double spigot pipe, and in installing sleeves on bell and spigot or double spigot pipe, the sleeve shall be adjusted so as to be central with both pipes and cover each pipe equally to make a joint symmetrical both radially and along the axis of each pipe. Reference marks satisfactory to the Engineer shall be placed on each pipe to show any displacement of the sleeve in caulking the joint, and the joint shall be caulked so as to prevent a material endwise displacement of the sleeve. The two joints of sleeves shall receive alternate partial caulking, or another method of caulking satisfactory to the Engineer may be employed.

711.05 PIPE LAID ON GRADES. --Where pipe is laid on grades, the bells pointing down grade shall have the lead joint made so as to avoid any material collection of air bubbles at the top of the joint.

711.06 POURING OF LEAD. --Only one pouring shall be made for each joint. The joint shall be perfectly clean and dry when the lead is applied. Dross shall not be allowed to accumulate in the melting pot.

In pouring lead joints no pour-through will be allowed. Any joint in which lead pours through to the interior of the pipe shall be rejected, the joint disassembled, and all lead removed from the interior of the pipe.

Lead extruded 1/8 inch or less from a joint under pressure may be recaulked upon approval of the Engineer; lead extrusions greater than 1/8 inch, and those not approved by the Engineer for recaulking, shall be melted out completely and remade. Furthermore, no leakage will be permitted at the joints. All joints not rendered leakproof by recaulking shall be melted out completely and remade. The hydrostatic field test shall be repeated and succeeding repair made as necessary to provide a completely leakproof line.

Pneumatic hammers used for caulking lead joints shall be Chicago Pneumatic Tool Company "Boyer Superior" No. 1, or approved equal, sleeve valve chipping hammers and each shall have a net weight of 10.50<sup>±</sup> 0.5 pounds, and at 90 p.s.i.g. air pressure shall deliver 5.5 foot pounds per blow and 2980 blows per minute.

711.07 MELTING OF JOINTS.—All lead joints of pipes to be disconnected, or altered by deflection, shall be melted out by means of a blow torch.

## **Section 712**

### **Payment**

Auxiliary Water Supply System for Fire Protection work, satisfactorily furnished and installed, or installed, as specified, will be paid for as set forth in the Proposal.

## **PART VIII**

### **LANDSCAPING**

#### **Section 800**

##### **General Requirements**

Unless otherwise indicated on the plans or specified in the Special Provisions, the performance of landscaping work shall be in accordance with the requirements set forth herein, and shall be coordinated with the installation of any landscaping irrigation facilities to be furnished and installed in conjunction therewith.

Existing surfaces shall be graded to provide proper drainage and to eliminate humps, surface irregularities, and depressions, which would allow water to stand.

Unless otherwise specified, existing planting in the area to be landscaped which is not to be used in the contract or salvaged as City property, shall be removed from the site by the Contractor as his property. Existing materials which will be used in the contract, or salvaged, shall be properly stored where directed until they are incorporated in the contract, or salvaged.

Planting shall be done only during weather that is favorable for the particular type of planting operation and plant involved.

Only experienced landscape gardeners shall handle, plant, trim, prune or water nursery stock.

As set forth in Section 105.01, the Contractor shall keep himself informed of, and shall comply with, the laws and regulations applicable to the work, particularly those laws related to the transportation and shipment of plants and materials. Certification of inspection of nursery stock shall be provided as may be required by Federal, State or other jurisdictions.

Before inclusion in the work, the Contractor, as specified in Section 106.13, shall deliver samples of materials for approval in ample time to enable the Engineer to make tests and examinations without causing any delay in the progress of the work.

All planting shall be satisfactorily completed in time to allow, within the period of time allowed for completion of all the work under a particular contract, the inclusion of the number of consecutive calendar days for plant establishment specified in the Special Provisions. The "Plant Establishment Period" shall be such specified number of consecutive calendar days following the satisfactory completion of all the specified planting operations under a contract and shall be a period of continuous satisfactory maintenance.

## Section 801

### Materials

801.01 GENERAL.—Materials, the furnishing thereof, and work related thereto, shall be as hereinafter specified except as otherwise indicated on the plans or in the Special Provisions.

#### 801.02 LOAM

General.--The Contractor shall furnish and place loam where, and to the depths, shown on the plans or specified, including the submission of samples and soil analysis report, testing, and all loading, hauling, placing, compacting and other incidental work.

Loam shall be imported, fertile, friable, natural, productive, clean, black topsoil, containing a normal amount of humus, and shall be capable of sustaining healthy plant life. Loam shall be free of subsoil, heavy or stiff clay, stones, rocks, gravel, stumps, brush, roots, weeds, noxious seeds, sticks, litter, trash, refuse, and other deleterious substances.

Loam shall not be infested with nematodes or with any other noxious animal life or toxic substances.

Loam shall be obtained from well-drained, arable land, and shall be of an even texture.

Loam shall not be taken from areas on which are growing any noxious weeds such as Morning Glory, Sorrell, or Bermuda Grass. A poor grade of sandy loam of low fertility, even though mixed with leaf mold, manure, or other fortifiers, will not be acceptable.

The Contractor shall make the site of his source of supply of loam available to the Engineer for inspection and approval prior to any hauling and placing of loam. In addition, the Contractor shall submit for approval a 2-cubic-foot sample of the loam he proposes to furnish, together with a standard soil analysis report showing chemical analysis of, and types of weed growth present in, the sample. The sample shall be delivered where directed two (2) weeks before starting the contemplated hauling of the loam to the site of the work.

The Contractor shall furnish another sample, following approval of the first sample, one-half cubic yard, which he shall store at the site of the work for comparison with subsequent loads of loam. The comparison sample shall be protected by a canvas cover until the furnishing of all loam has been completed and accepted.

Loam shall not be delivered to the site in a muddy condition; it shall be delivered reasonably dry and in a workable condition. Loam shall be placed and spread to the lines and grades shown on the plans or directed by the Engineer. Any extraneous or unacceptable materials not previously removed shall be raked off and removed from the site at the time of spreading the loam. Loam shall be properly compacted to the proper consistency for planting or lawn seeding, as applicable, to a uniform depth after compaction not less than the specified depth.

Topsoil.—The word "topsoil", as hereinafter used, shall refer to

loam salvaged from the area to be landscaped.

Payment. -- Loam, satisfactorily furnished and placed as specified, will be paid for as specified in the Special Provisions. When loam is specified to be paid for at the price bid per unit volume, the depth to be used in computing the volume shall be the depth, measured normal to the slope of the natural ground of the compacted loam in place, and the area shall be measured along the surface of the ground; and, when loam is specified to be paid for at the price bid per unit area, the area shall be measured along the surface of the ground.

### 801.03 OTHER TYPES OF MATERIALS

Soil Sterilizer or Weed Killer. -- Soil sterilizer or weed killer shall be an approved type which will permit planting and not inhibit normal growth of the nursery stock planted three (3) weeks after application. Compounds containing cyanide or arsenic will not be acceptable.

Commercial Fertilizer. -- Commercial fertilizer shall contain 6-percent available nitrogen, 9-percent available phosphoric acid, and 6-percent water soluble potash, and content in all cases shall be certified by the manufacturer.

Manure. -- Manure shall be well rotted, unleached, cattle, sheep or horse manure, free from dirt, rocks, weed seeds, harmful chemicals, or other objectionable materials. Only cattle manure meeting these requirements, shall be used for mulching purposes.

Manure Substitute. -- Approved soil amendments, in lieu of manure, may be used if specifications therefor are supplied by the Contractor and are approved by the Engineer. Specifications for one approved amendment follow:

A ground, relatively dry organic compost derived from sewage sludge and other organic residue, dust-free, aerobic, friable, free of objectionable odor and viable weed seed. Shall not contain lumps that will not pass a one-inch screen. Shall be registered with, and licensed for sale by, the California State Department of Agriculture.

Peat Moss. -- Peat moss shall consist of partially decomposed vegetable matter of natural occurrence, brown in color, clean, with low content of mineral and woody material, and shall have a pH within the range 5.0 to 6.5. Peat moss may be granular, powdered, or shredded.

Grass Seed. -- Each variety of seed, as specified hereinafter, shall be packed separately, delivered in good condition, and clearly tagged as required by law, showing the variety, purity, germination, and weed content. The seed shall be delivered as specified and must be guaranteed to be as stated on the tags.

The name of the type of seed, the minimum percentage of purity and germination, the maximum weed content and tolerances allowed for purity and germination are given hereinafter. Percentage of total quantity of each type of seed for a particular mixture shall be as set forth in the Special Provisions.

<u>Name of Seed</u>	<u>Purity Percent</u>	<u>Germination Percent</u>	<u>Maximum Weed Content Percent</u>
Kentucky Blue Poa Pratensis 20-lb. grade	90	85	0.50
Red Top Agrostis Vulgaris	90	90	1.00
Astoria Bent Blue Certified Agrostis Tenuls	98	90	0.20
Chewings Fescue Festuca Fallax	98	90	0.50
Perennial Rye Grass Domestic Blue Tag Certified (Lolium Perenne)	98	90	1.00

Determination of purity shall be made separately for each type of seed in the mixture. A minus tolerance of 2/10 of 1% in the specified purity of each type of seed will be allowed.

The following tolerances in germination will be allowed:

<u>Given Germination Percent</u>	<u>Allowable Variations Percent</u>
96 or over. . . . .	5
90 or over, but less than 96 . . . . .	6
80 or over, but less than 90 . . . . .	7
70 or over, but less than 80 . . . . .	8
60 or over, but less than 70 . . . . .	9
Less than 60 . . . . .	10

The Engineer will take a representative sample of each type of seed, seal the container and forward the sample to the State Department of Agriculture Seed Testing Division. The samples will be tested for purity, germination and weed content. The seals on the seed containers shall not be broken until the Engineer consents to same in writing. The Engineer may condemn any seed on which the seal has been broken prior to the time he consents to this action.

If the seed sample does not pass the specifications as determined by the tests made by the State Department of Agriculture, the Contractor shall immediately remove from the work the seed which did not meet specifications.

If it is in the City's best interest the Engineer may allow the seed to be sampled and tested by an approved private laboratory, but all

fees and expenses connected therewith shall be paid by the Contractor.

Straw or Hay. --Straw shall be clean and shall be new oat, barley or rice straw, or alfalfa hay.

Wire Mesh. --Wire mesh shall be 14-gauge minimum, 4-inch x 4-inch maximum galvanized reinforcing mesh.

Hexagon Netting. --Hexagon netting for protective fencing shall be 2-inch mesh, 20-gauge, galvanized netting.

Tree Stakes and Ties. --Tree stakes shall be constructed of 3-inch x 3-inch S4S "B & Btr" Industrial Grade Douglas fir posts on-the-job treated with 5 percent pentachlorophenol and painted green. Stakes shall extend a minimum of 96 inches above grade and 36 inches below grade and shall be placed in line with the direction of the prevailing wind, or in line with the street if applicable. Extension of stakes above grade may be reduced to a height of 48 inches for trees which are 48 inches, or less, in height. A 1/2-inch x 2-inch separator, painted to match the stakes, shall be added to each set of stakes for all trees.

Each tree shall be provided with 2 stakes clearing the trunk by 6 inches and each stake shall be tied to the trunk with 2 ties. Ties shall be one-inch diameter rubber hose of such length as not to restrict growth, and shall be attached to the stakes with galvanized nails.

Temporary Tree Guards. --When specified in the Special Provisions, the Contractor shall furnish and install a temporary tree guard for each tree. The tree guard shall be constructed of hexagon netting, of the width and as detailed on the plans. Netting shall be one-inch mesh, 20-gauge, galvanized poultry netting.

The temporary tree guards shall remain in place at the completion of the contract.

#### 801.04 QUALITY OF NURSERY STOCK

General. --Nursery stock shall be first class, representative of the normal species or variety, equal to, or exceeding the standards of the California Association of Nurserymen and applicable Federal and State Codes, and of the size and caliper specified on the plans or in the Special Provisions.

Only fresh vigorous, healthy, full, bushy, not leggy, well rooted, branched, shaped and established nursery stock, free from insects, disease, disfiguring knots, sun scald injuries, bark abrasions, or other disfigurements, shall be furnished.

Plants shall have been grown in a climate similar to the climate of San Francisco Bay Area.

Plants that become wilted anytime before planting will not be acceptable.

Unless otherwise specified, all plants shall have been reproduced by clonal propagation of name varieties; i.e., not from seeds.

Nursery stock nomenclature is based on the American Joint Committee on Horticultural Nomenclature, or on names generally accepted in the nursery trade.

Trees and Shrubs. --Trees and shrubs shall have been in containers at the time of delivery for not less than one (1) year nor more than three (3) years and shall not have been pruned prior to delivery.

Trees and shrubs which have severely cracked or broken root balls, or are root bound, will not be accepted. The root condition will be determined by the removal of earth of not less than two plants, nor more than 2 percent of each specie or variety. If such plants are unsatisfactory, the Engineer may inspect up to a maximum of 10 percent of that lot of each specie and variety and should a significant number of these prove unsatisfactory, the Engineer reserves the right to reject the entire lot. Plants which have had soil removed from the root system shall be considered as defective and shall be removed from the site by the Contractor at his expense.

801.05 STORAGE OF MATERIALS. --The Contractor shall store all nursery stock in areas specified, or designated by the Engineer. All such stored nursery stock shall be properly maintained and protected.

801.06 IDENTIFICATION OF MATERIALS. --Each and every variety of nursery stock shall be identified by its common name, specie, and variety printed on a hardwood tag which shall be fastened to the trunk of the tree, to the shrub or to the flat of ground cover, as the case may be. Identification tags shall be fastened to every tree and to 20 percent of the shrubs in each grouping of each variety throughout the project. Ground cover shall have one tag for each flat of each variety.

801.07 SAMPLES AND APPROVALS. --The Contractor shall deliver samples of loam, manure, peat moss and nursery stock, except for ground cover planting, at the job site where shown on the plans, or directed by the Engineer. In addition, samples of packaged, compounded and manufactured materials to be used in the work shall be delivered, as set forth hereinbefore, and copies of the specifications, labels and guarantees shall be sent to the City Engineer.

The quantity of samples, unless otherwise specified, shall be as follows:

- 1) Loam, 2 cubic feet, and 1/2-cubic yard, as specified in Section 801.02;
- 2) Manure, 1/2-cubic yard;
- 3) Peat Moss, one bale;
- 4) Trees and shrubs, not less than one plant, nor more than 5 percent of each specie and variety;
- 5) Packaged, compounded and manufactured items, one package of each.

The samples will, upon approval and written notification by the Engineer, constitute a "standard," which all materials furnished on the job shall equal or exceed in quality. All samples and planting material rejected due to being of a quality inferior to the "standards," shall be immediately removed from the site of the work and disposed of by the Contractor at his expense.

All approved sample materials shall be removed by the Contractor as his property after satisfactory completion of all planting operations as set forth in Section 807, except that the Contractor may use the

sample "standards" for the last material necessary for the work. Maintenance and protection of these "standards" for such use shall be the sole responsibility of the Contractor.

Substitution will be permitted only when the Contractor has submitted to the Engineer satisfactory written evidence that the specified material is unavailable. Samples of the substitute material shall be submitted as hereinbefore specified.

The Contractor shall notify the Engineer forty-eight (48) hours in advance of the time the nursery stock is to be received at the site. The Engineer will identify rejected nursery stock by painting a white lime stripe on the trunk or branches thereof. The Contractor shall supply the required white lime paste and brush.

801.08 PAYMENT. --Materials shall be furnished and work related thereto shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 802

### Site Preparation

802.01 GENERAL. --The Contractor shall prepare the site for landscaping. In the areas designated for landscaping on the plans, he shall:

- 1) Prior to placing imported material, replacing existing topsoil, or doing any planting, clear the areas of weeds, roots, debris, rocks, and underground obstructions, to a depth acceptable for planting;
- 2) Prior to placing loam or topsoil or doing any planting, chemically treat the areas to sterilize or kill weeds, as hereinafter specified, and then leave such areas for the period recommended by the manufacturer of the sterilizing agent. The Contractor will be held liable for any plants damaged by this chemical treatment;
- 3) Water, or allow the areas to dry, as necessary in the opinion of the Engineer, to provide the proper moisture for optimum planting conditions;
- 4) Before any planting is done, cultivate, rake, and roll, the areas to present a neat and uniform appearance.

802.02 INSTALLATION OF IRRIGATION FACILITIES. --The Contractor shall install the specified landscaping irrigation facilities where shown on the plans prior to preparation of the areas to be landscaped.

802.03 SOIL STERILIZATION. --Application of a soil sterilizing, or weed killing, agent to the area shall be in strict accordance with the recommendations of the manufacturer. The Contractor, by insti-

tuting all precautions necessitated by the type of chemical agent and its application, shall prevent any contact of the agent, occasioned by wind or otherwise, with persons or animals, or with existing planting, on private property or otherwise not specifically intended to be destroyed. Any such planting destroyed or damaged shall be replaced at the sole expense of the Contractor with healthy planting, of the type and at the stage of growth identical to that being replaced.

802.04 GRADING AND CULTIVATING. --Subsoil shall be scarified in rough contours to a depth of 3 inches in areas where loam is to be placed or topsoil is to be replaced.

The soil shall be cultivated and shall be graded and raked immediately before planting, to make a uniformly smooth, firm, friable, fine textured finished surface. Areas having slopes steeper than 2 to 1 shall not be cultivated, but any weeds thereon shall be cut to stubble 2 inches maximum in height.

Finished surfaces of planting areas adjacent to curbs or pavements shall be graded to one inch below curb or pavement elevations.

Grading equipment shall not be allowed over loam or topsoil after the areas have been prepared for planting.

The locations of trees and shrubs shall be staked out and the Contractor shall obtain approval of such locations from the Engineer before excavating planting pits.

802.05 PAYMENT. --Site preparation for landscaping shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **Section 803**

### **Trees and Shrubs**

803.01 GENERAL. --The Contractor shall furnish and plant trees and shrubs, complete in place, where and as shown on the plans or where directed, including excavating planting pits and disposing of materials removed therefrom, furnishing and placing prepared backfill material in the planting pits, forming water basins, furnishing and placing tree stakes, tree ties, peat moss, manure, and identification tags, furnishing and installing a temporary tree guard around each tree when specified, doing initial watering with a watering tube, and all other Incidental Work necessary, or required, to satisfactorily complete the planting.

Planting materials for trees and shrubs shall be in accordance with the applicable requirements of Section 801.

Materials removed in excavating for planting pits shall not be used as backfill material, but shall be removed from the site as the property of the Contractor.

803.02 EXCAVATION OF PLANTING PITS. --Planting pits for plants to be planted in street areas and parking lots shall be excavated to the following minimum sizes and depths, except as otherwise shown on the plans:

- 1) 36 inches square or round, as specified, x 36 inches deep for all trees and for shrubs in 5-gallon containers;
- 2) 18 inches square or round, as specified, x 18 inches deep for shrubs in one-gallon containers.

Pits for trees planted in removed sections of sidewalk, and having a course of masonry at the base of the tree, shall each be 42 inches deep or have additional depth equal to the thickness of the masonry and the setting bed.

Planting pits for plants to be planted in locations other than street areas and parking lots shall be excavated 6 inches wider and 6 inches deeper than the plant container, except as otherwise indicated on the plans.

The width of pits in slope areas stabilized shall be approximately 3 inches greater than the diagonal or diameter of the plant container and 6 inches deeper than the height of the container.

803.03 PLANTING OF TREES AND SHRUBS. --Each excavated planting pit shall be backfilled with a uniformly prepared material consisting by volume of one part manure, one part peat moss, and 6 parts loam.

The prepared backfill material in each planting pit shall be saturated with water and allowed to settle and dry for a period of at least twenty-four (24) hours.

When the prepared backfill can be satisfactorily worked, a hole shall be dug in the center of each planting pit large enough to accept the root ball. The depth of the hole shall be such that after the prepared backfill has settled, the top of the root ball will be at natural growing depth.

Each tree or shrub shall be centered in the planting pit in a plumb position, regardless of the slope of the ground.

Backfilling shall be performed around each root ball with the prepared backfill material specified hereinbefore. Backfill shall not be mechanically tamped or compacted around the roots or root ball during planting operations.

Neat and uniform basins suitable to the contours of the ground shall be formed for all tree and shrub planting pits. Basins shall be formed with level bottoms, shall have square dimensions or diameters equal to that of the planting pits, and shall have walls 6 inches high measured from the floor of the basin.

Trees and shrubs shall be irrigated with watering tubes immediately after planting, saturating the backfill from bottom to top, and exercising care not to touch the plant ball with the watering tube. The Contractor shall furnish enough watering tubes to suit the requirements of the planting. After initial watering, trees and shrubs shall be irrigated at least once each day, for a period of two (2) weeks, and sufficiently to keep the ground wet well below the root system.

Two inches of cattle manure shall be spread around each tree or shrub, keeping the mulch from contacting the bark or stem.

No pruning or shearing of plants shall be done unless specified on the plans or in the Special Provisions, or directed by the Engineer.

803.04 CENTER ISLAND AND SIDEWALK PLANTING. --Trees and shrubs planted in center islands having an irrigation system and not requiring slope stabilization, as well as trees planted in removed sections of sidewalk, shall be planted without basins around the pits and shall not be mulched.

803.05 APPLICATION OF COMMERCIAL FERTILIZER. --Two applications of commercial fertilizer shall be spread uniformly around all trees at the rate of 1/4 pound per tree for each application, at the time directed by the Engineer. One of the applications shall be applied during the week preceding the acceptance inspection at the termination of the contract.

803.06 MAINTENANCE. --Maintenance shall be in accordance with the applicable requirements of Section 807, "Maintenance and Plant Establishment."

803.07 PAYMENT. --Trees and shrubs, satisfactorily furnished and planted as specified, will be paid for at the respective unit price bid therefor.

## **Section 804**

### **Ground Cover**

804.01 GENERAL. --Ground cover nursery stock and lawn and the planting thereof shall be in accordance with the applicable requirements of Sections 800 and 801.

Site preparation shall be in accordance with the applicable requirements of Section 802.

Ground cover shall not be planted in an area until all trees and shrubs in that area are in place and all surplus material removed.

Spacing of ground cover nursery stock shall be as indicated on the plans or specified in the Special Provisions.

Ice plant (*Mesembryanthemum Edule*) cuttings shall be planted one (1) to a hole, on one-foot centers, in rows one-foot apart, ground measurement. Plants in adjacent rows shall be staggered.

804.02 SEQUENCE OF PLANTING FOR GROUND COVER NURSERY STOCK. --Planting pits shall be excavated to the proper size and depth to accommodate root systems without cramping.

Each plant shall be centered in the pit in a plumb position, regardless of the slope of the ground.

The pit shall be backfilled with friable soil.

The soil shall be carefully tamped around the plant, taking care not to bruise the plant.

The area planted with ground cover plants shall be watered immediately after planting.

The soil shall be cultivated to a uniform grade between plants, and commercial fertilizer shall be applied on the ground surface over the entire area at a rate of 15 pounds per 1000 square feet.

804.03 SEQUENCE OF PLANTING FOR LAWN. --The Contractor shall apply manure on the finished ground surface to a depth of 3/4 inch; shall disk it lightly into the surface of the loam or topsoil; and shall harrow, drag, roll, and cross-roll the surface to proper smoothness with a water-weighted roller.

The surface shall be raked lightly, and the seed sown evenly by a mechanical seeder at the rate of one pound of seed per 150 square feet. Sowing shall be done only under calm weather conditions.

After sowing, the surface shall be raked lightly to cover but not bunch, the seed.

The sown and raked surface shall be covered with peat moss at the rate of one bale per 500 square feet (1/4-inch deep).

The surface shall then be rolled with a smooth-surfaced, water-weighted lawn roller.

Immediately after completion of planting, the seeded area shall be watered with a fine spray of water to a depth of one inch penetration into the soil.

804.04 MAINTENANCE. --Maintenance shall be in accordance with the applicable requirements of Section 807, "Maintenance and Plant Establishment".

804.05 PAYMENT. --Ground cover nursery stock and lawn, satisfactorily furnished and planted as specified, will be paid for at the respective price bid per square foot, ground measurement.

## Section 805

### Slope Stabilization

**805.01 GENERAL.** --Where required on the plans or in the Special Provisions, the Contractor shall stabilize the slope areas in accordance with the requirements for the type specified and shall do all related and Incidental Work. If no specific type is set forth on the plans or in the Special Provisions, then the Contractor shall stabilize the slope areas in accordance with the requirements set forth under "Type II Stabilization" hereinafter. Prior to stabilization of an area, the Contractor shall remove or eliminate all gulleys, humps, and loose dirt.

**805.02 TYPE I STABILIZATION.** --The Contractor shall water the slope to achieve proper moisture content if, in the opinion of the Engineer, the area is too dry and cannot be readily compacted or worked.

Subsoil shall be roughened on rough contours with scarifier or cultivator type equipment in a series of 3-inch deep horizontal furrows spaced approximately 3 feet apart, slope measurement.

Loam, or topsoil, as applicable, shall be spread to the depth specified on the slope area to be stabilized.

Loam, or topsoil, as applicable, shall be compacted with one pass of a tamping roller. The tamping roller shall be of suitable weight and shall be equipped with straight steel studs, approximately 7/8-inch thick, placed approximately 8 inches apart, and staggered suitably. Studs shall be not less than 6 inches long nor more than 6 inches wide and shall be rounded to prevent withdrawing of straw from the soil.

Straw shall be spread evenly over the areas to be stabilized to an uncompacted thickness of not less than 6 inches, and straw, and loam or topsoil as applicable, shall be compacted into the slope by means of 2 passes of the hereinbefore specified tamping roller.

Straw shall be covered carefully and evenly with 14-gauge, 4-inch x 4-inch galvanized mesh reinforcing wire.

Mesh wire shall be drawn taut; adjacent edges of wire mesh shall be tied securely with 14-gauge wire at 18-inch intervals.

2-inch x 2-inch x 18-inch redwood stakes shall be driven into the soil in rows along the slope. The rows shall be 3 feet apart, slope measurement, and the stakes along the rows shall be spaced 3 feet apart and staggered with respect to adjacent rows. Wire mesh shall be tied securely to the stakes with 14-gauge wire.

Stakes shall be driven until mesh and straw are held tightly against the surface of the slope.

The end of the mesh at the top of the slope shall be extended 6 feet beyond the ridge line and embedded and secured with stakes. The end of the mesh at the toe of the slope shall be embedded and secured with stakes.

**805.03 TYPE II STABILIZATION.** --The Contractor shall water the slope to achieve proper moisture content if, in the opinion of the Engineer, the area is too dry and cannot be readily compacted or worked.

Subsoil shall be roughened on rough contours with scarifier or cultivator type equipment in a series of 3-inch deep horizontal furrows spaced approximately 3 feet apart, slope measurement.

Loam, or topsoil, as applicable, shall be spread to the depth specified on the slope area to be stabilized.

The soil shall be compacted with one pass of the tamping roller hereinbefore specified under "Type I Stabilization", and immediately evenly covered with a straw layer not less than 6 inches in uncompacted thickness.

Straw shall be embedded into the loose soil with 4 passes of the hereinbefore specified tamping roller.

**805.04 PAYMENT.** --Slope stabilization, satisfactorily done as specified, will be paid for at the lump sum price bid therefor.

## **Section 806**

### **Protective Fencing**

**806.01 GENERAL.** --Where required by the plans or the Special Provisions, the Contractor shall construct protective fencing of the specified types set forth hereinafter, complete in place, including all Incidental Work. Protective fencing shall remain in place at the completion of the contract. In general, protective fencing shall be constructed at the time of planting to the extent adequate to discourage trespassing on areas planted under the contract.

Strips of white cloth or plastic shall be fastened to the top wire of Type I and Type II fences, at a maximum spacing of 2 feet on centers, so that the strips will be plainly visible to potential trespassers.

**806.02 TYPE I FENCING.** --Type I fencing shall be constructed of 2-inch x 2-inch x 6-foot long S4S Industrial Grade Douglas fir posts painted green, driven 2 feet into the subgrade at 8-foot centers. One strand of No.14 gauge galvanized wire shall be furnished and installed between posts and attached by being looped around each post top and stapled thereto with galvanized staples.

**806.03 TYPE II FENCING.** --Type II fencing shall be the same as Type I, except that 3 strands of 14-gauge galvanized wire, equally spaced, shall be furnished, installed and attached to the posts.

**806.04 TYPE III FENCING.** --Type III fencing shall be the same as Type I, except 3-foot high hexagon netting, drawn taut, securely attached with wire to the 14-gauge galvanized top wire, and fastened to the posts by staples, shall be furnished and installed. The bottom edge

of the netting shall be one foot above the ground.

806.05 PAYMENT. --Protective fencing, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, ground measurement along the line of the fence, for the type of fence constructed.

## **Section 807**

### **Maintenance and Plant Establishment**

807.01 GENERAL. --The Contractor, from the time of planting, shall maintain all nursery stock and other planting planted under the contract, shall do all work to establish the satisfactory growth of such planted nursery stock and other planting, shall maintain the entire of the areas landscaped under the contract, shall continue such maintenance throughout the "Plant Establishment Period," and shall do all related and Incidental Work.

Maintenance shall include replacing any planted nursery stock or other planting which fails to establish normal healthy growth, or which is so injured or damaged, as to render it unsuitable for future growth, as determined by the Engineer. Replacement with healthy stock shall be made immediately upon withering or failure to grow, or within forty-eight (48) hours after notification by the Engineer; in addition, any replacements which fail to grow satisfactorily, as determined by the Engineer, shall be satisfactorily replaced by the Contractor; all at no additional cost to the City.

Maintenance shall also include keeping the landscaped areas free of weeds, rocks, debris and other deleterious material; maintaining and keeping in good repair the stakes and protective fencing; keeping plant irrigation basins and saucers properly formed; cultivating; restoring ground areas damaged by erosion or trespassing; doing all necessary watering including the furnishing of water and equipment for the use thereof; and doing all other work necessary, or required, for the satisfactory establishment of normal healthy growth of the planted nursery stock or other planting.

807.02 INSPECTION OF MAINTENANCE. --After planting, the site will be periodically inspected by the Engineer. Should the Contractor, after written notification by the Engineer of any deficiency in the maintenance or necessity for replacement of plants, fail to remedy such deficiency or make such replacement, the Engineer may cause such deficiency to be remedied or replacement made and the cost thereof deducted from moneys due the Contractor. Should the best interest of the City require immediate remedy without the delay incident to such notification, remedial action as necessary to alleviate the emergency will be taken and the cost thereof deducted from moneys due the Contractor.

807.03 COMPLETION AND ACCEPTANCE APPROVALS. --The Contractor shall notify the Engineer, in writing giving at least one week's notice, of the completion of all planting and related work. After inspecting the planting, the Engineer will notify the Contractor either of deficiencies therein or that the planting is satisfactory and that the "Plant Establishment Period" is effective as of that date. The completed planting must be approved before the start of the "Plant Establishment Period" is designated.

At least one week in advance of the expiration of the "Plant Establishment Period," the Contractor shall arrange with the Engineer for inspection of the landscaping. As a result of such inspection, the Engineer will notify the Contractor of deficiencies that must be corrected, or will accept the landscaping work and the City will assume responsibility for the subsequent maintenance thereof.

807.04 CULTIVATING. --Cultivating between plants shall be performed at least once every thirty (30) days, and shall have been done within seven (7) days prior to the inspection for approval of the completed planting and related work, and within seven (7) days prior to the inspection for approval of the completed plant establishment work.

807.05 TREE AND SHRUB MAINTENANCE. --Maintenance of trees and shrubs, and plant establishment work therefor, shall be in accordance with the applicable requirements of Sections 800 and 807, and shall include remulching with 2 inches of manure during the final two (2) weeks of the "Plant Establishment Period".

Any plants that have settled so that the top of the root ball is below the bottom of the basin or finished grade, as applicable, may, at the option of the Contractor, be raised to the specified level. All plants that have settled deeper than as specified immediately hereinbefore, or that have been raised and have failed to grow, shall be removed and replaced by the Contractor at his sole expense.

807.06 GROUND COVER NURSERY STOCK MAINTENANCE. --Midway in the "Plant Establishment Period", 15 pounds of commercial fertilizer shall be applied per 1000-square feet of ground cover area.

807.07 LAWN MAINTENANCE. --During the first two (2) weeks after planting, areas planted with lawn shall be watered sufficiently twice daily, once in the morning and once in the late afternoon, to keep the area uniformly moist. After the first two (2) weeks, watering shall be at least once each day until the end of the "Plant Establishment Period" and acceptance by the City. If the lawn area is sufficiently moist because of rain, as determined by the Engineer, watering will not be required. At no time shall the planted surface be permitted to become dry.

The lawn shall be mowed and trimmed when the grass reaches a height of 4 inches, after which the area shall be satisfactorily rolled. After initial mowing, the lawn shall be mowed once each week.

All bare spots on the lawn shall be reseeded.

The lawn shall be maintained for the duration of the "Plant Estab-

lishment Period", at the end of which time the lawn shall be mowed, weeded, and trimmed for final inspection.

807.08 WATERING. --After receiving their initial watering as specified in Sections 803.03 and 804.02, nursery stock shall be watered once a day for a period of two (2) weeks, then watered twice a week for the next thirty (30) days, and then watered once a week until final acceptance of the work by the City, all sufficiently to keep the ground wet well below the root system.

Areas planted with lawn shall be watered as specified in Section 807.07.

807.09 PLANT ESTABLISHMENT WORK. --The "Plant Establishment Period" shall be a period of continuous satisfactory maintenance, the duration of which will be as specified in the Special Provisions.

The "Plant Establishment Period" shall commence on the date designated by the Engineer after satisfactory completion and approval of the planting and related work.

Weeding shall be done periodically, often enough to prevent weeds from growing to 2 inches in height.

Weed control by chemical treatment will be permitted, but the Contractor shall be responsible for any damage to adjacent plants by the use thereof. The use of mowers and scythes will not be allowed.

Sand in planting pits for trees planted in sidewalk areas shall be replenished every thirty (30) days and prior to final inspection.

Irrigation basins shall be reformed and remulched prior to final inspection.

Additional work, in the judgment of the Engineer necessary for proper plant establishment, shall be done as Incidental Work. Examples of such work are: wind guards for trees and shrubs, stakes for shrubs, additional protective fencing, and drainage ditches.

Planting shall be replaced as necessary in accordance with the requirements of Sections 807.01 and 807.05. In addition, replacement trees and shrubs planted during the "Plant Establishment Period" shall each be clearly identified by a large, white, wooden tag attached thereto, showing the date of planting.

Plants, replacing those previously planted and not observed for the full "Plant Establishment Period," which, after acceptance of the work, fail to establish normal healthy growth will be considered to be defects in the work, and subject to the requirements of Section 105.10.

807.10 PAYMENT. --Maintenance and Plant Establishment work, satisfactorily done as specified, will be paid for at the lump sum price bid therefor.

## Section 808

### Restoration of Existing Lawn and Other Planting

808.01 GENERAL. --The Contractor shall not disturb existing lawn and planting except as necessary.

Where trenches and other excavations and land used by the Contractor are in existing lawn or other existing planted areas, the Contractor, as specified in the Special Provisions, shall either replace existing lawn by reseeding, or shall remove, store and subsequently replace existing lawn by resodding; and shall remove, store and subsequently replant all other existing vegetation other than ground cover planting; all, except as otherwise specified, to the extent required to be removed as a result of his operations; and shall maintain for the duration of the contract, all lawn and other planting replaced by him.

Lawn and other planting not required to be removed but damaged or destroyed by the Contractor's operations, plants not acceptable for replanting due to improper removal and storage, plants which the Contractor chooses to replace, and ground cover planting, shall be replaced with lawn and other planting, as applicable, at least equivalent in quality to that which existed prior to the work under the contract. In this case, replacement of existing lawn shall be by reseeding.

In order that future growth can be assured, the Contractor shall not delay completion of backfilling and restoration of lawn and other planting.

All lawn and other planting replaced by the Contractor, shall be planted, maintained, and inspected prior to acceptance, as hereinbefore specified for the respective type of planting.

808.02 MATERIALS. --Commercial fertilizer, manure, grass seed, peat moss and other materials necessary or required for the satisfactory restoration of existing lawn and other planting shall be as specified in Section 801.03.

808.03 REPLACEMENT OF TOPSOIL. --When excavating in existing lawn and other planted areas, the Contractor shall properly separate, as determined by the Engineer, topsoil from the other material excavated; or in lieu thereof, may furnish imported loam at his own expense.

The Contractor shall construct compacted backfill to the required subgrade for topsoil, and shall comply with the provisions of Sections 802.01 and 802.04.

He shall place topsoil or loam, as the case may be, and in lawn area replace the lawn sod if specified, to a thickness at least equal to that of the adjacent existing topsoil. In any case, a minimum depth of 8 inches of topsoil or loam, or topsoil or loam and lawn sod, as applicable, shall be placed.

Imported loam shall be in accordance with the requirements of Section 801.02.

Before any tree, shrub or ground cover replanting or lawn resodding or reseeding, topsoil, or loam, shall be fertilized with an application of commercial fertilizer, mixed thoroughly into the top  $\frac{1}{4}$  inch of topsoil, or loam, at the rate of 2 pounds per 100-square feet.

808.04 REPLACEMENT OF LAWN BY RESODDING. --Before removal of any lawn sod, the lawn shall be cut short and well watered. Lawn sod shall be lifted in 12-inch squares, 2 inches in thickness; shall be laid flat so that no square rests on top of another square, and placed in a shaded place; shall be protected during storage; and shall be watered at least three (3) times each day, when and as directed by the Engineer.

The Contractor shall carefully replace and tightly butt the squares of lawn sod, firmly hand tamp the replaced area, and fill any voids between squares with fine topsoil seeded as directed. The replaced lawn sod shall provide a smooth continuous lawn completely covering the appropriate area and conforming to adjacent grade, and shall be watered immediately following the replacement.

808.05 RESTORATION OF LAWN BY RESEEDING. --Restoration of existing lawn areas by reseeding shall be in accordance with the requirements of Section 804.03, "Sequence of Planting for Lawn."

Maintenance and plant establishment shall be in accordance with the applicable requirements of Sections 807.01 and 807.07.

808.06 PAYMENT. --Restoration of existing lawn and other planting damaged, destroyed or removed by the Contractor in the performance of his work shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **PART IX**

### **CONCRETE, METALWORK, PAINTING, AND MISCELLANEOUS**

#### **Section 900**

##### **Portland Cement Concrete and Related Materials and Work**

900.01 GENERAL.--Portland cement concrete, component materials therefor, mortar, grout, lime, additives for concrete, and certain concrete construction requirements, shall be as specified herein, except as otherwise stipulated on the plans or by the Special Provisions.

##### 900.02 PORTLAND CEMENT

General.--Cement shall be Portland cement and shall conform to the requirements of ASTM "Standard Specification for Portland Cement," Designation C 150, except as modified herein. Unless otherwise specified, cement shall be Type I or Type II.

Type I Portland Cement shall be used for concrete construction when white Portland cement or white cement is specified, and its chemical and physical composition shall be such that the completed concrete or mortar into which it is incorporated shall be permanently white in color.

Type II Portland Cement (moderate sulphate resisting and moderate heat of hydration) shall be used in concrete for all sewers including precast pipe sewers, and all sewer structures and manholes.

Type II Prestress Portland Cement shall be used for precast pre-stressed concrete construction, and shall be Type II Portland cement conforming to the specifications of ASTM Designation C 150, except as modified in the current edition of the State of California, Division of Highways, Standard Specifications.

Type II Modified Portland Cement shall be Type II Portland cement conforming to the specifications of ASTM Designation C 150, except as modified in the current edition of the State of California, Division of Highways, Standard Specifications, and shall be used only when specified on the plans or in the Special Provisions.

Type III Portland Cement shall be used when high-early strength is required in concrete construction. To accelerate the gain in strength of concrete, the Contractor may, at his expense, substitute, in identical required quantities, Type III Portland cement in lieu of Type I or Type II Portland cement, except when Type II Portland cement is specifically required. As an alternative to using Type III Portland cement, the Contractor may include an additional one-half sack of Type I or Type II Portland cement, as applicable, per cubic yard of concrete.

The use of Type III Portland cement in concrete for prestressed construction will not be allowed.

Type IV Portland Cement (low heat of hydration) shall be used only when specified on the plans or in the Special Provisions.

Type V Portland Cement (high sulphate resisting) shall be used only when specified on the plans or in the Special Provisions.

Any type and brand of Portland cement, if used in any portion of a structure presenting exposed surfaces, shall be used in all portions of that structure or combination of abutting structures presenting exposed surfaces to assure, insofar as practicable, no variation in color or shading for the exposed surfaces of any structure or combination of abutting structures.

All cement shall be delivered at the work in the original package, with the brand and the name of the manufacturer plainly marked thereon, unless shipped in bulk, in which case this information shall be contained in the shipping invoices accompanying the shipment. Satisfactory means shall be provided to protect cement from dampness until used. A sack of cement shall contain 94 pounds of cement net, and this quantity shall be considered as one cubic foot in volumetric proportioning.

Tests.--The Contractor, when requested, shall deliver to the Engineer not less than 5 samples of 4 pounds each of cement from the manufacturer's bin for testing by the City. Additional samples may be required commensurate with quantities of cement used and test results. He shall also, when requested, furnish the manufacturer's certificate of analysis and test, of any shipment of cement.

The Engineer may test samples taken either at the mill or at the work, or both. Shipments covered by satisfactory manufacturer's certificates will, after sampling, be released by the Engineer for immediate use. When the cement is of a brand not previously tested, or of a brand of which previous samples have not complied with the specifications, the Engineer may require any shipment to be held in storage until the completion of 3-day and 7-day tests.

All cement, the samples of which do not pass the specifications, and all cement which may have become damaged by exposure to moisture, shall be immediately and permanently removed from the work.

If it is found, by subsequent tests, that the cement used in any part of the work was not in accordance with the requirements of the specifications, then the Engineer may order the reconstruction of such part of the work. The Contractor shall perform such reconstruction at his own expense.

900.03 AGGREGATES.--Aggregates shall be free from deleterious coatings, clay balls, roots, bark, sticks, rags and other extraneous material.

All aggregates shall be thoroughly and uniformly washed before use.

Aggregates will be sampled at the discharge gates of the bins feeding the weigh hopper. The Contractor, at his expense, shall provide

safe and satisfactory facilities for obtaining the samples.

#### 900.04 FINE AGGREGATE

General.--Fine aggregate shall be natural sand or a combination of natural and manufactured sand, consisting of material of siliceous, granitic or igneous origin, and shall be hard and durable. It shall be free from oil and injurious amounts of clay, shale, mica or other objectionable materials.

When tested in accordance with the requirements of ASTM "Standard Method of Test for Organic Impurities in Sands for Concrete," Designation C 40, fine aggregate shall not show a solution color darker than the standard color solution.

The dry sand or fine mineral aggregate shall have a particle size distribution such that the percentage composition by weight, determined by test using standard sieves of square mesh wire construction, will conform to the following grading requirements:

Sieve Sizes	Percentage by Weight Passing
3/8" .....	100
No. 4 .....	95-100
No. 16 .....	45-80
No. 30 .....	25-55
No. 50 .....	10-35
No. 100 .....	2-10

In addition to the required grading analysis set forth hereinbefore, the distribution of the fine aggregate sizes shall be such that the difference between the total percentage passing the No. 16 sieve and the total percentage passing the No. 30 sieve shall be between 10 and 35 percent; and the difference between the percentage passing the No. 30 and No. 50 sieves shall be between 10 and 30 percent.

The gradation of the fine aggregate furnished for the work shall be of such uniformity that the material passing the Nos. 16, 30, and 50 sieves will not vary from the gradation initially approved by more than the following:

Max. variation of percentage of material passing the No. 16 sieve .....	+8
Max. variation of percentage of material passing the No. 30 sieve .....	+7
Max. variation of percentage of material passing the No. 50 sieve .....	+4

The variations shown immediately hereinbefore are the maximum allowable and will be reduced by the amount necessary to meet the grading requirements set forth in the grading analysis table.

Fine aggregate for use with white cement shall be Olympia sand, or approved equal.

Lightweight Aggregate.--Fine aggregate, when lightweight aggregates are specified, shall be in accordance with the requirements of ASTM Specifications for Lightweight Aggregates, Designations C 330,

C 331, and C 332, as applicable.

900.05 COARSE AGGREGATE

General.—Coarse aggregate shall consist of clean, hard, durable gravel, crushed gravel, or crushed rock, or combinations thereof. Aggregate containing more than 10 percent of inferior materials, flat or elongated particles, cracked or laminated rock, or rock which can readily be broken after immersion in water for one (1) hour, will be rejected. When shaken or washed in water, the volume of silt settling in one hour shall not exceed 3 percent of the volume of the sample.

Course aggregate for Portland cement concrete shall be in accordance with the applicable requirements of ASTM "Standard Specifications for Concrete Aggregates," Designation C 33, and shall be composed of and properly graded from aggregates segregated into the following two primary size groups which shall be identified by the normal size in each:

Sieve Sizes	Percentage by Weight Passing	
	Primary Aggregate Nominal Sizes	
	1½" x ¾"	¾" x No. 4
2" .....	100	--
1½" .....	90-100	--
1" .....	20-55	100
¾" .....	0-15	90-100
⅜" .....	0-5	20-55
No. 4 .....	--	0-15
No. 8 .....	--	0-5

The gradation of the primary aggregate nominal size, ¾-inch x No. 4, as furnished for the work shall be of such uniformity that the material passing the ⅜-inch sieve will not vary from the gradation initially approved by more than ± 8 percent; however, such variation is the maximum allowable and will be reduced by the amount necessary to meet the grading requirements set forth in the grading analysis table.

The primary size aggregate groups shall be free of perceptible amounts of crusher dust, as determined by the Engineer.

Except in the case of nominal ¾-inch x No. 4 aggregate, coarse aggregate shall be furnished from both of the primary size groups listed in the foregoing table. Aggregate of each size group shall be handled separately and combined with the other size when the aggregates are proportioned for each batch of concrete.

Lightweight Aggregate.—Coarse aggregate, when lightweight aggregates are specified, shall be in accordance with the requirements of ASTM Specifications for Lightweight Aggregates, Designations C 330, C 331 and C 332, as applicable.

900.06 COMBINED AGGREGATE GRADINGS

General.—Fine aggregate, and coarse aggregate of the primary aggregate nominal sizes, in each batch of concrete shall be combined in proportions that will produce a mixture within the grading limits for combined aggregates specified immediately hereinafter unless other-

wise specified; however, within these limitations, the exact proportions of aggregate sizes used in the concrete mix shall be as designated by the Engineer.

Sieve Sizes	Percentage by Weight Passing	
	1-1/2" Max.	3/4" Max.
2" .....	100	--
1-1/2" .....	90-100	--
1" .....	50-86	100
3/4" .....	45-75	90-100
3/8" .....	38-55	60-80
No. 4 .....	30-45	40-60
No. 8 .....	23-35	30-45
No. 16 .....	17-27	20-35
No. 30 .....	10-17	13-23
No. 50 .....	4-9	5-15
No. 100 .....	1-3	1-5
No. 200 .....	0-2	0-2

Lightweight Aggregate.—Fine and coarse lightweight aggregates in each batch of concrete shall be combined in proportions that will produce a mixture within the grading limits for combined aggregates as set forth in ASTM Specifications for Lightweight Aggregates, Designations C 330, C 331 and C 332, as applicable, unless otherwise specified.

900.07 WATER.—Water used for washing aggregates and for mixing and curing concrete shall be fresh and clean, free from oil, acid, alkalis, vegetable matter, or other deleterious substances. No salt water, brackish water, or water containing excessive amounts of sulphates or chlorides, as determined by the Engineer, shall be used.

900.08 ADMIXTURES

General.—Approved air-entraining admixtures, approved admixtures to decrease the permeability of concrete to water, and calcium chloride as an admixture to accelerate the setting of concrete pavement and pavement base may be used at the option of the Contractor. Approval thereof, and approval for the use of any other admixture, if the use thereof will be allowed, shall be obtained from the Engineer in writing, prior to the use of any admixture.

No admixtures of any kind will be permitted in concrete for prestressed concrete construction.

In no case shall the required amount of cement be reduced because of the addition of an admixture to the concrete.

The use of calcium chloride in any reinforced concrete is prohibited.

The composition, use and testing of all admixtures for concrete, including cement interground with admixtures during the manufacturing process, and the testing of concrete to which an admixture has been added, shall be in accordance with the applicable ASTM Specifications,

examples of which follow:

"Standard Method of Test for Weight per Cubic Foot, Yield, and Air Content (Gravimetric) of Concrete", Designation C 138.

"Standard Specifications for Air-Entraining Portland Cement", Designation C 175.

"Standard Method of Test for Air Content of Hydraulic Cement Mortar," Designation C 185.

"Standard Method of Testing Air-Entraining Admixtures for Concrete," Designation C 233.

"Standard Specifications for Air-Entraining Admixtures for Concrete," Designation C 260.

All phases of the addition of an approved admixture, or cement containing an admixture, to the concrete mix shall be under the strict control of the Engineer.

When applicable because of the type of admixture added to the concrete mix, a compensating reduction of mixing water therein shall be made in accordance with the recommendations of the manufacturer of the admixture, subject to the requirements, as for slump, of the specifications, and to the approval of the Engineer.

The curing of concrete and mortar containing an admixture shall be in accordance with the recommendations of the distributor of such admixture, in all respects in which such recommendations are more stringent than those specified herein.

The furnishing, using and testing of admixtures for concrete, whether or not the admixtures are interground with the cement during the manufacturing process, and subsequent testing of concrete containing admixtures, shall be considered Incidental Work.

Calcium Chloride.--When used as an admixture to accelerate setting of concrete, calcium chloride shall be in accordance with the requirements of ASTM "Standard Specifications for Calcium Chloride," Designation D 98, and shall be added to the concrete mix in the following manner.

Calcium chloride shall be added to the concrete mix in the form of a solution made by adding calcium chloride to water in the ratio of 4 pounds of calcium chloride to 4/5 of a gallon water, which stated amounts will yield one gallon of solution. The solution shall be agitated by air jets, paddles or other suitable means to completely dissolve the calcium chloride.

The amount of solution added to the concrete mix shall be such that not more than 2 pounds of calcium chloride per sack of cement are added to the mix.

The total amount of water used in the mix shall not be in excess of the amount of water normally required to obtain the slump and strength specified in Section 900.11.

The Contractor shall provide tanks or other suitable storage facilities wherever the concrete is mixed to assure a constant satisfactory supply of calcium chloride.

Use of Type III Portland Cement not Restricted.--The use of high-early strength Portland cement (Type III) is not in any way restricted by the aforementioned requirements for admixtures and may be used

by the Contractor at his option in lieu of Type I or Type II Portland cement in the identical quantities specified, or required, for such cements, subject to the restrictions set forth in Section 900.02.

900.09 MORTAR AND GROUT.—Mortar shall be Portland cement mortar in accordance with the following table:

<u>Class of Mortar</u>	<u>Examples of Uses</u>	<u>Sacks of Cement</u>	<u>Cubic Ft. of Sand</u>
A	Finish mortar for curbs and steps; caulking for pipe joints . . . .	1	1½
B	Mortar for brick manhole exteriors and brick bulkhead walls in sewers and sewer structures . . . . .	1	2
C	Mortar for brickwork exposed to concentrated sewage, manhole invert brick, and sewer invert brick . . . . .	1	1

Grout shall be composed of Class "C" mortar diluted with water to required consistency.

Sand for mortar for use in pipe joints or brickwork need not pass the grading requirements of Section 900.04, provided it is in accordance with the following grading requirements:

<u>Percentage by Weight Passing</u>	
No. 10 Sieve . . . . .	100
No. 50 Sieve, not over . . . . .	85
No. 80 Sieve, not over . . . . .	15

Mortar may be mixed in either a mixing machine or in a watertight box. In either method, the materials shall be accurately measured. If a machine is used to mix the mortar, all the materials, including any coloring matter, and sufficient water, shall be put in the mixer and allowed to mix at least one (1) minute.

If the mortar is mixed by hand, the materials, including any coloring matter, shall be measured in a watertight box and turned at least 3 times with a hoe or shovel. Sufficient water shall then be added, and the mixing continued until the batch is uniform in color and consistency. All mortar must be used immediately after mixing, and re-tempered mortar shall not, in any case, be used.

900.10 HYDRATED LIME.—Hydrated lime shall be in accordance with the requirements of ASTM "Standard Specifications for Normal Finishing Hydrated Lime," Designation C 6.

Hydrated lime shall be used only when specified. It shall be used in the proportion directed, but such proportion shall not exceed 8 pounds of hydrated lime per sack of cement.

900.11 CLASSES OF CONCRETE. --Portland cement concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, and water, proportioned and mixed as herein specified.

The different classes of concrete shall conform to the following limiting requirements. Any deviation of the mix from the specifications must be approved by the Engineer.

Class	Max. Size of Coarse Aggregates in Inches	Min. No. of Sacks of Cement per Cu. Yd. of Concrete	Slump in Inches	Min. Strength in Lbs. per Sq. Inch at 28 Days
A	3/4	7	3-5	3,500
A-1	1-1/2	7	3-5	3,500
B	3/4	6	3-5	3,000
B-1	1-1/2	6	3-5	3,000
C	3/4	5-1/2	3-1/2 Max.	3,000
C-1	1-1/2	5-1/2	3-1/2 Max.	3,000
D	1-1/2	4	4 Max.	2,000

The class of concrete used shall be as specified on the plans or in the Special Provisions. Examples of the class of concrete intended for various types of construction are as follows:

Class A. --Columns requiring high working stresses due to heavy loading.

Reinforced concrete in sea water or frequently wetted thereby.

Concrete deposited under water.

Concrete piles.

Concrete exposed to strong sulfate ground waters or other corrosive liquids or salts.

Concrete handrails and posts, fence rails and unplastered balustrades.

Class A-1. --Class "A-1" may be used in lieu of Class "A" for heavy-section columns, slabs, walls, footings, etc., where reinforcement clearances and structural dimensions will permit.

Class B. --Reinforced concrete columns, girders, beams and slabs.

Bridge members.

Water tanks.

Reinforced concrete retaining walls.

Sewers and sewer structures.

Piers and abutments.

Tunnel linings.

Reinforced concrete buildings.

Floor slabs placed directly on the ground.

Machinery foundations.

Footings.

Concrete curb.

Combined monolithic curb and gutter.

Combined monolithic curb and parking strip.

Pull boxes, junction boxes, foundations for electrical equipment and pressure type vehicle detectors.

Class B-1. --Class "B-1" may be used in lieu of Class "B" for heavy-section columns, slabs, walls, footings, etc., where reinforcement clearances and structural dimensions will permit.

Class C. --Concrete sidewalk.

Concrete gutter.

Class C-1. --Concrete parking strip.

Concrete pavement and pavement base.

Class D. --Mass concrete.

Gravity retaining walls.

Backfilling to foundation grades.

Should the quantities of ingredients designed to produce a cubic yard of concrete result in a volume (yield) greater or less than one cubic yard, the amounts of fine and coarse aggregate shall be changed as necessary to maintain the required quantity of Portland cement in each cubic yard of concrete.

The slump of concrete shall be determined in accordance with the requirements of the ASTM "Standard Method of Test for Slump of Portland Cement Concrete," Designation C 143, which is a slump cone test, or by the "Kelly Ball" method of test. For any batch of concrete, the results of the "Kelly Ball" method of test will be the approved equivalent of the required slump. Any concrete not meeting the slump requirements tabulated in the table set forth hereinbefore shall be immediately removed from the site of the work.

900.12 PROPORTIONING AND STORING CONCRETE AGGREGATES AND CEMENT. --The specified size groups of aggregates shall each be stored in a separate bin, and combined with cement and water as herein provided. The fine and coarse aggregates shall be combined in the proportion governed by the requirements of Section 900.06.

Aggregates shall be stored or stockpiled in such manner that separation of coarse and fine particles of each size group will be avoided, and also that the size groups will not become intermixed before proportioning.

In placing aggregates in storage or in moving them from storage to the weighing hopper of the batching plant, any method that may cause segregation, degradation, or combining of materials of different gradings, resulting in failure to meet the grading requirements at the weighing hopper, shall be discontinued.

Aggregates shall be handled in a manner that will restrict particle breakage to a practical minimum; towards this objective, the use of suitable devices to reduce impact of falling aggregates may be required by the Engineer.

Fine aggregate, coarse aggregate and bulk cement shall be measured by weighing in approved weighing devices. The correctness of all such weighing devices shall be certified by the Sealer of Weights and Measures of the City as and at the intervals provided by law, or more frequently when necessary to insure their accuracy while in use on the

work. Each weighing unit shall include a visible springless dial type scale which will indicate the scale load at all stages of the weighing operation from zero to full capacity, or an over-and-under indicator which will show the scale in balance with no load and when loaded at any desired beam setting.

Bulk cement shall be kept separate from the aggregates until the batch ingredients are released for discharge into the mixer, and shall be weighed in a separate hopper from that used for the aggregates.

The cement hopper may be attached to a separate scale for individual weighing or, provided the cement is weighed before the other ingredients, it may be attached to the aggregate scale for cumulative weighing.

When sacked cement is used, each batch of concrete shall contain a whole number of sacks; splitting of sacks of cement will not be permitted. As the cement sacks are emptied they shall be neatly piled in bundles of 50 to facilitate counting by the Engineer.

### 900.13 MIXING CONCRETE

General. -- All concrete shall be mixed in mechanically operated mixers, except that when permitted by the Engineer, batches not exceeding  $1/3$  cubic yard may be mixed by hand methods in accordance with the provisions set forth hereinafter under "On-Site Mixed Concrete."

Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer. The pick-up and throw-over blades of mixers shall be restored or replaced when any part or section is worn one inch or more below the original height of the manufacturer's design. Mixers and agitators having an accumulation of hard concrete or mortar, or not otherwise clean to bare metal, shall not be used.

Whenever a concrete mixer is not adequate or suitable for the work, it shall be removed from the work and a suitable mixer provided.

The total elapsed time between contact of damp aggregates with the cement and the start of mixing shall not exceed thirty (30) minutes.

The batch shall be so charged into the mixer that some water will enter the already rotating drum in advance of cement and aggregates. All water shall be in the drum by the end of the first  $1/4$  of the specified mixing time.

All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cement.

On-Site Mixed Concrete. -- When concrete is mixed at the site of the work, the mixers used shall be of the paving or stationary type. The size of batch shall not exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America.

When the concrete is mixed, the weighed aggregate shall first be dumped into the skip, after which the cement shall be added from sacks. In no case shall the cement be emptied from the sacks onto the aggregate in the truck before dumping into the skip. The sacks of cement shall be handled with care to avoid wastage of cement, and the cement

shall be so spread in the skip as to prevent loss when the skip is raised. Each sack shall be completely emptied by proper shaking. Before use, the sacks of cement shall be distributed along the work in piles, each pile containing the required number of sacks for one batch.

Hand-mixed concrete shall be made in batches of not more than  $1/3$  cubic yard and shall be mixed on a watertight, level platform. The proper amount of coarse aggregate shall be measured in measuring boxes and spread on the platform and the fine aggregate shall be spread on this layer, the 2 layers being not more than one foot in total depth. On this mixture shall be spread the dry cement and the whole mass turned not less than 3 times dry, then sufficient clean water shall be added, evenly distributed, and the whole mass again turned not less than 4 times, not including placing in the carriers or forms.

Ready-Mixed Concrete. -- Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set forth in ASTM "Standard Specifications for Ready-Mixed Concrete," Designation C 94, except as otherwise specified herein, or hereinafter under "Transporting Mixed Concrete."

Ready-mixed concrete shall be mixed and delivered to the site of the work by means of one of the following combinations of operations:

- 1) Mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in truck agitators. (known as central-mixed concrete)
- 2) Mixed partially in a stationary mixer, and the mixing completed in a truck mixer. (known as shrink-mixed concrete)
- 3) Mixed completely in a truck mixer. (known as transit-mixed concrete)

Mixers may be stationary mixers or truck mixers. Agitators may be truck mixers operating at agitating speed or truck agitators. Each mixer and agitator shall have attached thereto, in a prominent place, a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades.

Truck mixers shall be equipped with electrically or mechanically actuated revolution counters by which the number of revolutions of the drum or blades may readily be verified. The counters shall be of the continuous-registering, non-resettable type, which accurately register the number of revolutions, and shall be mounted on the truck mixer so that the Engineer may safely and conveniently inspect them from alongside the truck.

Truck mixers shall be loaded not to exceed the manufacturer's guaranteed capacity. They shall combine the ingredients of the concrete into a thoroughly mixed and uniform mass and discharge the concrete with a satisfactory degree of uniformity. Any batch showing segregation of materials upon delivery will be rejected.

When shrink-mixed concrete is furnished, concrete that has been partially mixed at a central plant shall be transferred to a truck mixer and all requirements for transit-mixed concrete shall apply. No credit in the number of revolutions at mixing speed shall be allowed for par-

tial mixing in a central plant.

Transporting Mixed Concrete. -- Mixed concrete shall be transported to the delivery point in truck agitators or truck mixers operating at the speed designated by the manufacturer of the equipment as agitating speed.

Truck agitators shall be loaded not to exceed the manufacturer's guaranteed capacity. They shall maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless ordered by the Engineer. If the Engineer orders additional water to be incorporated into the concrete, the drum shall be revolved not less than 30 revolutions at mixing speed after the water is added and before discharge is commenced. Any unauthorized addition of water to the mix will be cause for rejection of the entire truckload.

The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

Discharge shall be completed within  $1\frac{1}{2}$  hours, or before 250 revolutions of the drum or blades, whichever comes first, after the introduction of the cement to the aggregates. Under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 degrees Fahrenheit, or above, a time less than  $1\frac{1}{2}$  hours will be required.

Each batch of ready-mixed concrete delivered at the job site shall be accompanied by a ticket showing volume of concrete, the weight of cement in pounds and the total weight of all ingredients in pounds, unless otherwise ordered by the Engineer. The ticket shall also show the time of day at which the materials were batched and, for transit-mixed concrete, the reading of the revolution counter at the time the truck mixer is charged.

Time or Amount of Mixing. -- The required mixing time, in paving or stationary mixers, of concrete used for concrete structures shall be not less than ninety (90) seconds nor more than five (5) minutes.

When transit-mixed concrete is furnished, each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment on the metal plate on the truck mixer as mixing speed. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials, including mixing water, shall be in the mixer drum before starting the count of the number of revolutions of mixing.

900.14 PLACING CONCRETE. -- Before placing concrete, all debris, chips and loose dirt shall be removed from the forms, all temporary bracing and cleats taken out, all openings for pipes properly boxed, all forms properly secured in their correct positions and made tight, and all reinforcement cleaned and secured in its proper place. Concrete shall not be placed in any form until that form, and the reinforcement therein, has been inspected and approved for the placing of concrete.

Concrete shall not be placed during freezing or other adverse weather conditions unless approved protective measures are taken.

All forms, while concrete is being poured therein, shall be completely detached from runways and mixer supports so that concrete in the process of setting will be entirely free from any vibration whatever.

Any concrete which may be on the forms or reinforcement and is set and dry in advance of the completed work, shall be cleaned off and removed, and forms and reinforcing steel washed clean before fresh concrete is deposited. In structures, and where waterproofing is necessary, a layer of neat cement mortar shall be placed between set concrete and wet concrete.

Good runways, where necessary for concrete buggies, shall be provided to convey the concrete to place, in order not to displace the forms or reinforcement. Running buggies directly across reinforcing bars will not be permitted, nor will wheeling buggies or walking on concrete within twelve (12) hours after it has been deposited.

Concrete shall be conveyed in such manner that there will be no separation of the ingredients, and in cases where such separation occurs or there has been a delay in placing, the concrete may be rejected unless, in the opinion of the Engineer and with his specific approval, it can be satisfactorily remixed before placing. In any event, concrete which has attained initial set, and that for which more than one hour has elapsed since the initial introduction of water thereto, shall not be incorporated into the work.

Concrete shall not be dropped through the reinforcing steel in such a manner as to cause segregation of the aggregates. In no case, within the formwork or otherwise, shall concrete be permitted to fall from a height greater than 6 feet except through approved adjustable-length pipes or "elephant trunks."

Reinforcement, anchor bolts or other fixtures that are to be embedded in the concrete shall not be displaced.

Concrete shall be thoroughly compacted by vibration during and immediately after placing. The Contractor shall provide a sufficient number of approved electrical, pneumatic or other mechanical internal vibrators, operators therefor, and helpers, to so compact each batch of concrete.

Each vibrator shall be inserted directly in the concrete at each location for a period of from twenty (20) to thirty (30) seconds, depending on the consistency of the concrete, at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. No vibrator shall be attached to either the reinforcing steel or the forms, unless the Special Provisions allow external vibration on forms. Vibration shall be of sufficient duration to thoroughly compact the concrete and work it around the reinforcement and embedded fixtures and into the corners and angles of forms, but shall not be continued so long as to cause segregation of the concrete.

Vibration shall be supplemented by such spading as is necessary to insure smooth and dense concrete, free from air pockets, rock pockets and honeycombed areas, along form surfaces, in corners and in loca-

tions inaccessible to vibrators.

The concrete shall be placed in layers about 12 inches in thickness and, insofar as practicable, the work on each part of the structure shall be prosecuted in a manner such that the concrete in each layer is placed before the concrete immediately under it has initially set.

The placing of fresh concrete against old or set concrete shall be done as specified in Section 900.15.

Subgrade surfaces on which pile-supported concrete is placed shall be adequately prepared to assure proper support for the placed concrete until such concrete has sufficient strength to span, and be supported solely by, the piles.

During construction of pavement, the method of placing concrete shall be such as to prevent segregation of the concrete materials and avoid damage to the subgrade, and not require more than a minimum of rehandling of the concrete. Each batch shall be conveyed over the subgrade by means of a boom and bucket, or other approved device, and deposited within the area to be covered by that batch. The use of a chute will not be allowed in pavement construction, unless otherwise specified in the Special Provisions, or permitted by the Engineer.

#### 900.15 CONSTRUCTION JOINTS

For Structures. --Construction joints for structures shall be located, in lieu of specific instructions to the contrary, at points of minimum shear, and shall be formed so as not to impair the strength or appearance of the concrete structure.

Before starting any concreting operation, the unit of concrete placement between construction joints shall be approved by the Engineer. The entire predetermined unit shall be completed in a single placement operation.

The entire contact surface of old or set concrete against which fresh concrete is to be placed shall be cleared of laitance, thoroughly cleaned, washed with clean water in such manner that free water does not remain on the surface, and then covered with a layer of neat cement mortar of creamy consistency. The fresh concrete shall be thoroughly worked against the mortar-covered surface.

All concrete in vertical members, such as columns and walls, shall be in place not less than four (4) hours before any concrete is placed in girders, beams or slabs directly over, and connected to, such vertical members. All excess water and laitance that rises to the top of such vertical members shall be removed, and the concrete cut away as necessary to insure full strength of the concrete at the joint with girders, beams and slabs.

For Curbs and Pavements. --Construction joints for curbs, combined curb and gutter, concrete pavement base, and concrete pavement, shall be in accordance with the respective requirements therefor of PART II of these Standard Specifications.

#### 900.16 PROTECTING AND CURING CONCRETE

General. --All fresh concrete, including gunite, shall be adequately protected from weather, sun, and mechanical injury, until thoroughly

set and the strength thereof is sufficient to prevent damage, and shall be cured by the use of water, an approved impervious membrane, or as otherwise specified. When high-early strength cement or, in the case of pavement base or pavement, calcium chloride as an admixture is used, the Engineer may approve reduction of the required protection and curing periods, but only to a degree that will not be detrimental to the concrete.

Where required to prevent crazing or cracking of the surfaces of concrete pavement, pavement base, bridge decks, flat slabs, etc., the exposed finished surfaces of the concrete shall be kept damp by applying water with a nozzle that so atomizes the flow that a mist, and not a spray, is formed, until the concrete is hard enough to permit the substitution of one of the conventional curing methods covered hereinafter, or otherwise specified. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

Water Curing.--When water is used for curing, the concrete shall be kept wet for a period of 7 days after pouring, so as to prevent the appearance of dry patches. This shall be accomplished by ponding, by the use of a sprinkler system, or by means of a 2-inch layer of sand or earth or suitable cotton mats, rugs or carpets kept moist by sprinkling twice a day. Only clean, fresh water shall be used. After the curing period, the earth or sand shall be completely removed, and the concrete surface shall be thoroughly cleaned.

Surfaces enclosed in timber forms shall be kept moist for 7 days by wetting or other approved means commensurate with weather or other conditions affecting moisture retention.

Impervious Membrane Curing.--When concrete, other than concrete pavement base, is cured by the impervious membrane method, the curing shall be done by the use of an approved liquid which will form a practically colorless, impervious, nonslippery membrane when dry. The liquid shall have a temporary color sufficient to indicate the extent of its application. It shall form a hard film and shall thoroughly waterproof the concrete surface within thirty (30) minutes. The curing compound shall be applied at a uniform rate of one gallon per 150-square feet of area.

When concrete pavement base is cured by the impervious membrane method, the curing shall be done by the use of an approved liquid of the asphalt cut-back type, which will form a permanently dark colored, impervious, nonslippery membrane when dry. The liquid shall form a hard film and shall thoroughly waterproof the concrete surface within thirty (30) minutes.

Membrane type curing liquids shall be applied under pressure with a spray nozzle at such a rate as to seal the surface uniformly and completely.

The seal shall be protected from injury for ten (10) days, and any breaks in the membrane during this period shall be immediately and satisfactorily repaired by a fresh application of the same liquid.

900.17 REPAIRING IMPERFECT CONCRETE. --Voids or stone pockets discovered when the forms are removed shall not be repaired until inspected by the Engineer.

After removal of the forms, all concrete found to be poorly mixed or placed, or out of line or level, shall be removed and repaired or replaced as necessary to conform to the design shape and strength.

Where required, pockets containing either rocks or voids shall be cleaned out to sound concrete, the edges of which at the surface of the structure shall be cut normal to such surface. The so exposed sound concrete shall be generously brushed with neat cement mortar, and proper repair made with concrete, or cement mortar, as directed, held in place with forms if necessary. The brand and type of cement shall be that used for the structure, and the color of the concrete or mortar shall be otherwise controlled so that the patched area will match the contiguous concrete.

Concrete placed, tests of which do not meet the specified strength requirements, shall be removed by a method approved by the Engineer, and each section removed shall be reformed and the concrete replaced. All costs of additional testing performed by the City, including corings and Schmidt hammer readings, required as a result of inferior concrete, shall be borne by the Contractor and will be deducted from payments due him.

900.18 PREPARING CONCRETE FOR PAINTING. --If the Special Provisions require the painting of concrete, all concrete surfaces to be painted shall be prepared in accordance with the requirements of Section 909.03.

900.19 PAYMENT. --Portland cement concrete and related materials and work shall be furnished and incorporated in the construction as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 901

### Metal Castings

#### 901.01 CAST IRON

General. --Gray iron for cast iron castings shall be such as to make a casting that will be tough, strong, sound, of even grain, and in accordance with the applicable requirements of ASTM "Standard Specifications for Gray Iron Castings," Designation A 48, Class 30. The tensile strength shall be considered the primary test for qualification under these specifications. In certain cases a transverse bending test may be required by the Special Provisions to a minimum test value specified therein; in such event, the bending test will be conducted in accordance with the requirements of ASTM "Standard Method for Transverse Testing of Gray Iron," Designation A 438.

Test Bars. --The Contractor shall, at his own expense, cast, machine, and provide bars for tensile strength tests, and when applicable, also for transverse bending tests, in accordance with the applicable requirements of the ASTM Specifications referred to hereinbefore. The actual tests will be made by the City at no expense to the Contractor. At least 2 bars representing each lot of castings shall be submitted to the Engineer for testing. Bars shall be poured, and shall represent true samples of the metal used in the castings.

Rejection of Materials. --Should the results of testing fail to meet all the requirements herein specified, all castings made from the lot which the specimens represent will be rejected.

Cleaning and Inspection. --All castings which have passed the required tests shall be thoroughly cleaned, inside and out, without the aid of acid or other liquid, and shall be subjected to careful inspection and hammer tests. The castings shall be of the dimensions shown on the plans, and shall be free from sand or blow holes and cold shuts. No plugging or stopping of holes will be allowed. Casting lines and excess materials shall be ground smooth.

After the castings have been tested and cleaned, as described hereinbefore, they shall be weighed and the weight shall not vary more than 8 percent of that indicated on the plans for any particular casting, and not more than 4 percent on the whole lot of castings. The weight of each casting shall be painted with white paint on the outside of the casting. Unless otherwise specified, no casting will be accepted on the work unless the weight is plainly marked thereon.

Patterns. --The Contractor shall assume full responsibility for the correctness and condition of all patterns, whether furnished by him or borrowed from the City.

Marking. --Each casting shall have distinctly cast on the outside thereof such letters and numbers as the Engineer may direct. The letters and numbers shall be not less than  $1\frac{1}{2}$  inches in length and  $1/8$  inch in relief, unless otherwise specified.

#### 901.02 CAST STEEL

General. --Steel castings shall be in accordance with the applicable

requirements of ASTM "Standard Specifications for Mild- to Medium-Strength Carbon-Steel Castings for General Application," Designation A 27, Grade 65-35.

Test Specimens. --The Contractor shall, at his own expense, provide and finish all test pieces in accordance with the applicable requirements of the ASTM Specifications referred to hereinbefore. The actual tests will be made by the City at no expense to the Contractor. At least one specimen representing each lot of castings, or heat in the case of chemical analysis, shall be submitted to the Engineer for testing. Each test piece shall be cut cold from coupons attached to some portion of one of the castings where practicable, or cut cold from coupons attached to separate cast blocks, and shall receive the same treatment as the casting or cast block before the specimen is cut out and before the coupon is removed from the casting or cast block.

Rejection of Materials. --Should the results of testing fail to meet all the requirements herein specified, all castings made from the lot, or heat in the case of chemical analysis, which the specimens represent, will be rejected.

Cleaning and Inspection. --All castings which have passed the required tests shall be thoroughly cleaned, inside and out, without the aid of acid or other liquid, and shall be subjected to careful inspection and hammer tests. The castings shall be of the dimensions shown on the plans, sound and free from all defects or imperfections which may render them unfit for use. Casting lines and excess materials shall be ground smooth.

After the castings have been tested and cleaned, as described hereinbefore, they shall be weighed and the weight shall vary not more than 5 percent of that indicated on the plans for any particular casting, and not more than 3 percent on the whole lot of castings. The weight of each casting shall be painted with white paint on the outside of the casting. Unless otherwise specified, no casting will be accepted on the work unless the weight is plainly marked thereon.

Patterns. --The Contractor shall assume full responsibility for the correctness and condition of all patterns, whether furnished by him or borrowed from the City.

Marking. --Each casting shall have distinctly cast on the outside thereof such letters and numbers as the Engineer may direct. The letters and numbers shall be not less than  $1\frac{1}{2}$  inches in length and  $1/8$  inch in relief, unless otherwise specified.

901.03 PAYMENT. --Metal castings shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 902

### Miscellaneous Steel, Iron and Hardware

**902.01 STEEL.** --Steel, except steel for structures, as covered in Section 425 and reinforcing steel as covered in Section 421.05, shall be fabricated and installed in accordance with the requirements set forth on the plans or in the Special Provisions. In the absence of such coverage, steel shall conform to the requirements of ASTM "Standard Specifications for Steel for Bridges and Buildings," Designation A 7, except that steel manufactured by the acid-Bessemer process shall not be used.

**902.02 WROUGHT IRON.** --When wrought iron is specified, it shall be in accordance with the requirements of the appropriate ASTM Standard Specifications among which are the following:

"Rolled Wrought Iron Shapes and Bars," Designation A 207

"Wrought Iron Plates," Designation A 42

"Uncoated Wrought Iron Sheets," Designation A 162

"Zinc-Coated (Galvanized) Wrought Iron Sheets," Designation A 163

"Welded Wrought-Iron Pipe," Designation A 72

The Contractor shall certify in writing that the materials installed are of wrought iron in accordance with the appropriate ASTM requirements. Manufacturer of wrought iron and point of origin shall also be included in the certification.

### **902.03 BOLTS, NUTS, WASHERS, ETC.**

**General.** --All bolts and nuts, except as otherwise specified, shall conform to the requirements of ASTM "Standard Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners," Designation A 307. Bolts shall have heavy hexagon heads and nuts shall be of the hexagon heavy series. All bolts, washers, nuts, anchor bolts, screws and other hardware shall be galvanized, except as otherwise specified, and all galvanized nuts shall have a free running fit. Bolts shall be of ample size and strength for the purpose intended.

No existing bolts, nuts, washers, etc., shall be reused in contract work, unless specifically indicated for such reuse on the plans or in the Special Provisions.

**High Strength Steel Bolts.** --High strength steel bolts, together with their nuts and washers, except as otherwise specified, shall conform to the requirements of ASTM "Standard Specification for High Strength Carbon Steel Bolts for Structural Joints, Including Suitable Nuts and Plain Hardened Washers," Designation A 325. High strength steel bolts, nuts, and washers shall not be galvanized, unless so specified on the plans or in the Special Provisions.

The methods of installation, including required bolt lengths, of high strength steel bolts, nuts and washers for structural type work shall be in accordance with the latest revision of the "Specifications for Structural Joints Using ASTM A 325 Bolts" of the Research Council

on Riveted and Bolted Structural Joints of the Engineering Foundation.

The installation of high strength steel bolts, nuts and washers for work other than structural type work shall be in accordance with the recommendations of the manufacturers of the bolts, nuts and washers and as specified for the purpose intended.

902.04 PAYMENT. --Miscellaneous steel, iron and hardware shall be furnished and installed as Incidental Work and payment therefor shall be included in the price or prices bid.

**Section 903**

**Chain Link Fence**

903.01 GENERAL.—The Contractor shall construct chain link fence of galvanized chain link fabric secured to metal posts, top rails, or top tension cables, as applicable, and bottom tension wires, complete, in place, with all necessary stretcher bars and bands, fabric ties, hardware, appurtenances, concrete footings for posts, and when required, compression and tension braces, extension arms and wire, and gates.

The height of the fabric, the fence type, the use of extension arms and wire, the use of gates, and other special requirements, shall be as indicated on the plans or specified in the Special Provisions.

903.02 FENCE TYPES. --Type "A" fence shall be 3 feet, 3 feet 6 inches, 4 feet, or 5 feet in height, as specified, and shall include top rails and bottom tension wires.

Type "B" fence shall be 4 feet, 5 feet, or 6 feet in height, as specified, and shall include top tension cables and bottom tension wires. Terminal posts for Type "B" fence shall be braced with diagonal compression and diagonal tension braces.

Type "C" fence shall be 6 feet, 7 feet, 8 feet, or 9 feet in height, as specified, and shall include top rails and bottom tension wires. Terminal posts for Type "C" fence shall be braced with horizontal compression braces and diagonal tension braces.

903.03 POSTS AND FOOTINGS

Fence Posts. --Fence posts shall be in accordance with the following requirements:

<u>Fence Type</u>	<u>Corner, End, and Pull Posts</u>	<u>Line Posts</u>
"A"	2.375" O.D. Steel Pipe at 3.65 Lbs. / Lin. Ft. or 2" Steel Square Section at 3.65 Lbs. / Lin. Ft.	1.900" O.D. Steel Pipe at 2.72 Lbs. / Lin. Ft. or 1.875" Steel "H" Section at 2.75 Lbs. / Lin. Ft.

Fence Type	Corner, End, and Pull Posts	Line Posts
"B"	2.875" O.D. Steel Pipe at 5.79 Lbs. / Lin. Ft. or 2½" Steel Square Section at 5.79 Lbs./Lin. Ft.	2.375" O.D. Steel Pipe at 3.65 Lbs. / Lin. Ft. or 2¼" Steel "H" Section at 4.1 Lbs./Lin. Ft.
"C"	2.875" O.D. Steel Pipe at 5.79 Lbs. / Lin. Ft. or 2½" Steel Square Section at 5.79 Lbs./Lin. Ft.	2.375" O.D. Steel Pipe at 3.65 Lbs. / Lin. Ft. or 2¼" Steel "H" Section at 4.1 Lbs./Lin. Ft.

Note: 1½-inch nominal size pipe has 1.900-inch outside diameter (O.D.)  
2-inch nominal size pipe has 2.375-inch outside diameter (O.D.)  
2½-inch nominal size pipe has 2.875-inch outside diameter (O.D.)

Gate Posts. --Gate posts shall be pipe of the following sizes for single swing gates or one leaf of double swing gates:

Width of Each Gate Unit	Nominal Size of Post in Inches	Nominal Weight of Post Per Linear Foot in Pounds
Up to and including 6 feet	2½ (2.875 O.D.)	5.79
Over 6 feet to 13 feet, incl.	3½ (4.000 O.D.)	9.11
Over 13 feet to 18 feet, incl.	6 (6.625 O.D.)	18.97
Over 18 feet	8 (8.625 O.D.)	24.70

Terminal Posts. --Terminal posts are defined as all posts to which ends of the fabric are secured and shall include corner, end, pull and gate posts.

Footings. --All posts shall be set in cast-in-place Class "B" concrete footings, crowned to shed water. Each post shall be of sufficient length to provide a 36-inch setting in each concrete footing, except that each line post for Type "A" fence heights of 4 feet and shorter shall be of sufficient length to provide a 30-inch setting in each concrete footing.

Concrete footings for all posts shall extend a minimum of 3 inches below the post pipe. The minimum cross sectional dimension of concrete footings shall not be less than 8 inches, and terminal posts for Types "B" and "C" fence shall have footings with a minimum cross sectional dimension of 9 inches. In the event of adverse ground conditions or in locations subject to extreme wind, the size of the concrete footings shall be increased as shown on the plans or specified in the Special Provisions.

On concrete walls, the post pipes shall be set in 3-inch diameter nominal size pipe sleeves embedded a minimum of 18 inches into the wall. The post pipe shall clear the bottom of the sleeved hole by ½

inch. The annular space between each post pipe and sleeve shall be filled with an approved dry-packed expansive mortar, or hot pure sulphur sealed flush with  $\frac{1}{2}$  inch of grout at the top.

Installation. --All posts shall be installed plumb and measured parallel to the ground surface at a spacing not to exceed 10'-0" center to center.

Corner posts shall be installed at all changes in horizontal line of 30 degrees or more.

Pull posts shall be installed at all changes in vertical line of 10 degrees or more. Pull or other type terminal posts shall be installed at intervals not to exceed 300 feet.

All posts shall be fitted with malleable iron, or 13-gauge minimum pressed steel, tops designed to prevent the entrance of water and carry the top rail or top tension cable, as applicable.

Each line post top shall have an opening to accommodate a 1.660-inch O.D. pipe top rail, or top tension cable, as applicable.

Each terminal post top shall be a driven fit.

#### 903.04 FENCE BRACING

General. --Corner and pull posts for Types "B" and "C" fence shall each be braced in adjoining bays.

All braces shall be fitted without end play.

Compression Braces. --Compression braces shall be 1.660-inch O.D. steel pipe weighing 2.27 pounds per linear foot and connected to the posts with end cups of either malleable iron or 12-gauge minimum pressed steel, and end bands.

Tension Braces. --Tension braces shall each be a 3/8-inch diameter rod fitted with turnbuckle, and connected to the terminal post with an end band and connected to the line post either with an end band or, in the case of Type "C" fence, to the end cup of the compression brace.

Top Rails, Couplings, and Cups. --Top rails for Types "A" and "C" fence shall be 1.660-inch O.D. steel pipe weighing 2.27 pounds per linear foot. No length of top rail between splices shall pass through less than 2 posts. The top rails shall pass through all intervening line post tops and form a continuous brace between terminal posts without end play.

Top rail couplings shall be malleable iron, or 14-gauge minimum pressed steel, not less than 6 inches long, inside sleeve type with outside center boss, or outside sleeve type with inside center boss. Rail cups shall be malleable iron, or 12-gauge minimum pressed steel. Lugs on rail cups may be offset.

#### 903.05 FENCE TENSION CABLES AND WIRES

General. --Bottom tension wires shall be installed on Types "A", "B" and "C" fence. Top tension cables shall be installed on Type "B" fence.

All tension cables and wires shall be installed taut, straight, and without kinks.

Top Tension Cable. --A continuous, 7-strand, 3/8-inch diameter, steel tension cable shall be installed as shown on the plans, passing

through the tops of all intervening line posts and connected to each terminal post with an end band and 2 cable clamps and with not less than one turnbuckle between terminal posts. The line post tops shall be of the type hereinbefore specified.

Bottom Tension Wire. --A continuous No. 7-gauge, coil spring steel, bottom tension wire shall be installed as shown on the plans, connected to the terminal posts with end bands and to all intervening line posts with fabric ties. Each run of bottom tension wire between terminal posts shall be fitted with not less than one turnbuckle.

Grade Between Posts. --The bottom tension wire shall be installed on a straight grade between posts by excavating the high points of ground along the line of the fence. Unless otherwise shown on the plans or specified in the Special Provisions, depressions along the line of the fence shall not be filled.

### 903.06 FENCE FABRIC

General. --Chain link fence fabric shall conform to the applicable requirements of ASTM "Standard Specifications for Zinc-Coated Steel Chain-Link Fence Fabric," Designation A 392. Fence fabric shall be 2-inch square mesh, with horizontal and vertical diagonals, right-hand weave, copper bearing steel wire with knuckled-knuckled selvages, stretched taut and securely fastened to the outside of the posts and other framework of the fence, and shall be continuous between terminal posts and spliced by weaving.

Gauge of fabric for Types "A" and "B" fence shall be 11 gauge.

Gauge of fabric for Type "C" fence shall be 9 gauge.

The fabric shall be installed on a straight grade between posts by excavating the high points of ground.

Connections to Terminal Posts. --Connections to terminal posts shall be with 3/16-inch x 3/4-inch minimum, stretcher bars and bands using steel bolts not less than 5/16-inch diameter.

End bands and stretcher bar bands shall be of steel not less than 1/8-inch x 3/4-inch and fitted with steel bolts not less than 3/8-inch diameter except as hereinbefore specified.

Connections to Line Posts, Top Rails, Top Tension Cable, and Bottom Tension Wire. --Connections to line posts, top rails, top tension cable and bottom tension wire shall be with either fabric ties of 9-gauge steel wire minimum or 6-gauge aluminum wire minimum, or hog rings, 12-gauge steel wire minimum or 9-gauge aluminum wire minimum, as applicable, except that 13-gauge steel wire hog rings may be used for connection to the bottom tension wire.

903.07 GATES. --Gates shall be of the widths shown on the plans or specified in the Special Provisions. Gate posts shall be as hereinbefore specified.

Gate frames shall be rigid and shall be constructed of not less than 1½-inch diameter (1.900-inch O.D.) galvanized standard weight pipe conforming to the requirements of ASTM "Standard Specifications for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses", Designation A 120. Gate frames shall

be cross-trussed with 3/8-inch diameter adjustable truss rods. Corners of gate frames shall be fastened together and reinforced with malleable iron fittings designed for the purpose, or by welding. All welds shall be ground smooth.

The hereinbefore specified chain link fence fabric shall be attached to gate frames by the use of stretcher bars and fabric tie wires, as specified for fence construction. Stretcher bar bands or bolts shall be spaced at approximately one-foot intervals.

Each gate shall be hung by at least 2 steel or malleable iron hinges not less than 3 inches in width and so designed as to securely clamp to the gate post and permit the gate to be swung back against the fence. The bottom hinge shall have a socket to take the ball end of the gate frame.

Each gate shall be provided with a combination steel or malleable iron catch and locking attachment of approved design. A stop shall be provided to hold each gate open and a center rest with catch shall be provided for each gate, all where required. Each gate shall be equipped with an approved lock. Two keys shall be furnished for each lock and each key shall have attached to it a one-inch round brass key tag stamped as specified in the Special Provisions.

#### 903.08 GALVANIZING

General. --All steel and iron fencing materials shall be hot-dip galvanized in accordance with the applicable requirements set forth in Section 907; moreover, the galvanizing of certain units and appurtenances as specified hereunder shall fulfill the requirements of the Preece test as set forth in ASTM "Standard Method of Test for Uniformity of Coating by the Preece Test (Copper Sulphate Dip) on Zinc-Coated (Galvanized) Iron or Steel Articles," Designation A 239.

Framework. --Terminal posts, line posts, braces, top rails, gate parts, and all other appurtenances constituting the fence framework, excepting tension cable, tension wire, bolts, hog rings, and tie wires, shall be hot-dip galvanized and shall be capable of withstanding 12 one-minute immersions under the Preece test.

Fabric. --Fence fabric shall be hot-dip galvanized after weaving; galvanizing shall be of Class II weight class with a minimum of 2.0 ounces of zinc per square foot of uncoated wire surface in accordance with ASTM "Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric," Designation A 392; and this galvanizing shall be capable of withstanding 6 one-minute immersions under the Preece test.

Appurtenances. --Appurtenances such as tension cable, tension wire, bolts, hog rings, and tie wires shall be hot-dip galvanized but will not be required to be subjected to the Preece test.

903.09 PAYMENT. --Chain link fence, including gates, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, measured along the top rail or top tension cable, as applicable, of the completed fence between centers of posts.

## Section 904

### Pipe Handrailing

**904.01 GENERAL.** --The Contractor shall construct pipe handrailing complete, in place, as shown on the plans including drilling vent holes, welding, expansion joints, grinding, cleaning, galvanizing, grouting and painting.

**904.02 MATERIALS AND FABRICATION.** --The elements of the pipe handrailing shall be standard weight, or heavier, black steel pipe conforming to ASTM "Standard Specifications for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses", Designation A 120.

The railing shall be fabricated by welding. Welding shall be in accordance with the requirements of Section 906. All welds and sharp edges shall be ground perfectly smooth. Neat regular bends shall be made where indicated on the plans and where required to fit conditions.

Only those welds necessary, as shown or indicated on the plans, for the fabrication of the handrailing and provision of the specified expansion joints will be allowed. The Contractor shall not construct or cut sections of handrailing, for galvanizing or for any other reason, so that any welds in addition to those specified hereinbefore will be required.

Fabrication and installation drawings shall be furnished in accordance with the requirements of Section 106.08.

Particular attention shall be given to the finish of the rails. Any imperfections or roughness, and all sharp edges, shall be ground smooth.

Railing dented, bent, broken, warped or otherwise damaged, shall be immediately and satisfactorily repaired or replaced, as applicable, by the Contractor at his sole expense.

**904.03 GALVANIZING.** --Prior to galvanizing, adequate vent holes shall be drilled in each closed element of the railing.

Handrailing and appurtenances shall be hot-dip galvanized in accordance with the requirements of Section 907.

**904.04 ERECTION.** --The pipe railing, as erected in final position, shall be rigid and without any loose joints or connections. The posts shall be truly vertical and the rails shall conform to line and grade. The posts shall be anchored in place as shown on the plans.

Where pipe is to be embedded in an oversize hole formed in concrete, the annular space between such pipe and the concrete shall be filled with an approved dry-packed non-shrink mortar.

**904.05 PAYMENT.** --Pipe handrailing, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, measured along the top rail between the extreme ends of the railing as installed.

## Section 905

### Bridge Railing

905.01 GENERAL. --The Contractor shall construct bridge railing complete, in place, as shown on the plans, including drilling vent holes, welding, expansion joints, grinding, cleaning, galvanizing, grouting and painting.

905.02 MATERIALS. --The top and bottom rails, and the posts and balusters of the bridge railing shall be structural steel tubes, shapes and bars, or steel pipe, as shown on the plans, conforming to ASTM "Standard Specification for Structural Steel," Designation A 36, or ASTM "Standard Specifications for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses," Designation A 120, as applicable, and the applicable requirements of Section 902 of these Standard Specifications.

905.03 FABRICATION. --Bridge railing shall be fabricated by welding. Welding shall be in accordance with the requirements of Section 906. All welds and sharp edges shall be ground perfectly smooth. Neat regular bends shall be made where indicated on the plans and where required to fit conditions. The method of anchoring and supporting the railing shall be as shown on the plans.

Expansion joints shall be spaced as shown on the plans, and shall have a straight and close smooth fit, but allow movement due to expansion and contraction.

Only those welds necessary, as shown or indicated on the plans, for the fabrication of the metal railing and provision of the specified expansion joints will be allowed. The Contractor shall not construct or cut sections of railing, for galvanizing or for any other reason, so that welds in addition to those specified hereinbefore will be required.

Fabrication and installation drawings shall be furnished in accordance with the requirements of Section 106.08.

Particular attention shall be given to the finish of the horizontal rails. Any imperfections or roughness thereof shall be ground smooth. No offset shall occur at the expansion joints, and all sharp edges shall be ground smooth.

Railing dented, bent, broken, warped or otherwise damaged, shall be immediately and satisfactorily repaired or replaced, as applicable, by the Contractor at his sole expense.

905.04 GALVANIZING. --Prior to galvanizing, adequate vent holes shall be drilled in each closed element of the railing.

Bridge railing and appurtenances shall be hot-dip galvanized in accordance with the requirements of Section 907. To reduce the number of field welds to a minimum, galvanizing shall be done after fabricating the railing into the largest units possible to galvanize in accordance with the hereinbefore specified limitation on cuts and welds.

905.05 INSTALLATION.--The bridge railing, as erected in final position, shall be rigid and without any loose joints or connections. The posts shall be truly vertical and the rails shall conform to line and grade.

After erection, the base plates shall be grouted in place. The grout shall be in accordance with the requirements of Section 900.09, and shall contain an approved admixture that will prevent shrinkage. Iron filings will not be permitted. The grout shall be mixed with the minimum amount of water for proper hydration and shall be thoroughly packed in place.

905.06 PAINTING.--When specified, painting shall be in accordance with the applicable requirements of Section 909.

905.07 PAYMENT.--Bridge railing, satisfactorily constructed as specified, will be paid for at the price bid per linear foot, measured along the top rail between the extreme ends of the railing as installed.

## Section 906

### Welding

906.01 GENERAL.--All welding shall be performed in accordance with the applicable requirements of the latest codes, rules, or specifications of the American Welding Society (AWS) and the requirements of these specifications and the Special Provisions.

Structural steel shall not be welded unless specified on the plans or in the Special Provisions, or permitted in writing by the Engineer. Welding of structural steel, in general, shall be done by the metal-arc welding process and in accordance with the latest "Standard Specifications for Welded Highway and Railway Bridges," Serial Designation D 2.0, of the American Welding Society, except as otherwise recommended by the electrode manufacturer and approved by the Engineer.

Welding of other work shall be done in accordance with the applicable codes, rules, or specifications listed immediately hereinafter:

AWS "Standard Code for Arc and Gas Welding in Building Construction," Serial Designation D 1.0;

AWS "Rules for Field Welding of Steel Storage Tanks," Serial Designation D 5.1;

AWWA - AWS "Standard Specifications for Elevated Steel Water Tanks, Stand Pipes and Reservoirs," Serial Designation D 5.2; and

AWWA - AWS "Standard Specifications for Field Welding of Steel Water Pipe Joints," Serial Designation D 7.0.

Welding of work not covered by the requirements listed hereinbefore shall be done in accordance with the requirements of the welding codes,

rules, regulations, or specifications of those societies, institutes, bureaus, or associations referred to on the plans or in the Special Provisions, or shall be done as otherwise specified.

906.02 WELDING OPERATORS.--All welding operators shall be qualified in accordance with the requirements of the applicable AWS Specifications. Qualification tests shall be run by a recognized testing laboratory at the Contractor's expense. Previous recent qualification by the State of California Division of Highways will be acceptable.

All welding operators shall be subject to examination for requalification using the equipment, materials and electrodes employed in the execution of the contract work. Such requalification, if ordered by the Engineer, shall be done at the expense of the Contractor.

906.03 ARC-WELDING ELECTRODES.--Arc-welding electrodes shall comply with the requirements of ASTM "Standard Specification for Mild Steel Arc-Welding Electrodes," Designation A 233, and shall be of Classification E-60 Series. Electrodes shall be compatible with welding positions, type and polarity of current, and other conditions of intended use.

Bare electrodes shall not be used as such electrodes reduce the strength of the weld. Welding work to be subsequently galvanized, therefore, shall be thoroughly cleaned and prepared so as not to impair the quality of the galvanizing.

906.04 GAS-WELDING RODS.--Iron and steel gas-welding rods shall comply with the requirements of ASTM "Standard Specifications for Iron and Steel Gas-Welding Rods," Designation A 251; the welding and rod classification numbers selected shall be suitable for the condition of intended use.

906.05 GAUGES.--Gauges for checking weld dimensions shall preferably be the standard gauges specified by the American Welding Society, but other gauges may be used if specially adapted to the work and approved by the Engineer. The Contractor shall supply at least 2 gauges to the Engineer for his use during the period of welding operations.

906.06 WORKMANSHIP AND TECHNIQUE.--Workmanship and technique shall conform with the applicable requirements of the latest codes, rules, or specifications of the American Welding Society, except as otherwise specified.

All welding shall be done in the shop before galvanizing, if the latter is required, except as specifically otherwise permitted by the Engineer.

Surfaces to be welded shall be cleaned by wire brushing, chipping, or hammering away any loose mill scale, rust, paint or other foreign matter present on the metal. The cleaning shall extend at least 2 inches on each side of the weld, except as otherwise specified. Welds shall be cleaned each time the electrode is changed.

In assembly and during welding, the component parts shall be held

by sufficient clamps or other adequate means to keep the parts in their proper positions and in close contact.

Welds shall show uniform sections, smoothness of metal, feather edges without undercuts or overlays and freedom from cracks, porosity or clinkers. Visual inspection of edges and ends of fillets and butt joint welds shall indicate good fusion with, and penetration into, the base metal. All burrs and lumps of metal shall be removed, leaving a neat and workmanlike appearance.

All weld slag and spatter shall be completely removed before galvanizing or painting.

906.07 DEFECTIVE AND DEFICIENT WELDS.--Welds or portions of welds found defective by the Engineer shall be removed and replaced, or if deficient in dimensions, shall be corrected, all in accordance with the applicable requirements of the latest codes, rules, or specifications of the American Welding Society, and to the satisfaction of the Engineer.

906.08 PAYMENT.--Welding shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 907

### Galvanizing

907.01 GENERAL.--Galvanizing of steel and iron shall be done where shown on the plans or specified in the Special Provisions.

Products, fabricated from rolled, pressed and forged steel shapes, plates, bars and strip, 1/8-inch thick and heavier, required to be galvanized, shall be hot-dip galvanized in accordance with the requirements of ASTM "Standard Specifications for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip," Designation A 123. Galvanizing shall be performed after fabrication, and after modification if such operations involve machine or die work, milling, cutting, shearing, punching, drilling, forming, bending, thread cutting, welding, riveting, or the like.

Material required to be galvanized shall not be shop painted.

All components of bolted assemblies including bolts, nuts, washers, etc., shall be galvanized separately before assembly.

To reduce the number of field welds to a minimum, galvanizing shall be done after fabrication into the largest sections possible to galvanize in accordance with the hereinbefore specified limitation on cuts, welds, connections, etc.

When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating.

The Contractor shall thoroughly clean all grease, paint, rust and

other foreign materials from the surface of the steel by pickling. After pickling, the steel shall be wire-brushed to remove any remaining foreign material.

The temperature in the galvanizing tank shall be continuously maintained during all galvanizing operations at the lowest temperature between the limits of 825 and 835 degrees Fahrenheit that will result in the complete and uniform galvanizing of all immersed surfaces.

The weight of the zinc coating deposited on each of the surfaces of the steel to be galvanized, for 1/8-inch and 3/16-inch thick steels, shall average for the entire work not less than 2.0 ounces per square foot of each surface, and for any individual specimen shall not be less than 1.8 ounces per square foot of surface. For 1/4-inch thick and heavier materials, the coating weights shall average not less than 2.3 ounces per square foot and no individual specimen shall show less than 2.0 ounces per square foot.

The galvanizing shall be applied in such a manner that the zinc coating will not peel off, will be adherent, thorough, continuous and smooth, and will be free from imperfections such as blisters, gritty areas, uncoated spots, acid spots, black spots, dross and flux. All galvanized surfaces having such imperfections shall be satisfactorily recleaned and regalvanized by the Contractor at his sole expense. The zinc coating may have chill spots, rack marks, lumps and other projections that can be satisfactorily corrected by filing smooth, yet leaving a sound, adequately thick zinc coating. Such projections shall be filed smooth.

Two (2) coats of paint, of high zinc dust content, conforming to the requirements of Federal Specification MIL-P-21035, shall be applied to any final assembly field cuts and welds necessary, in the judgment of the Engineer, to be made after galvanizing, after such welds have been ground smooth. It is emphasized that such welds will not be allowed to compensate for errors in planning, cutting or fitting, and shop hot-dip galvanizing will be required after any such modification.

Galvanized surfaces that have become abraded or otherwise damaged to such extent as to expose the base metal at any time after the application of the zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coatings, after which the cleaned areas shall be painted as indicated hereinbefore.

907.02 IRON AND STEEL HARDWARE. --Iron and steel hardware, including castings, rolled, pressed, and forged articles, bolts, screws, nuts, washers, rivets, nails, and similar articles, required to be galvanized, shall be hot-dip galvanized after fabrication in accordance with the applicable requirements set forth in Section 907.01 and the requirements of ASTM "Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware," Designation A 153, which provide for zinc coatings ranging from not less than 0.85 ounce per square foot of surface in the case of small bolts, screws, nuts and washers, and rivets and nails, to not less than 1.80 ounces per square foot of surface in the case of castings, and rolled, pressed, and forged articles.

Components of bolted assemblies shall be galvanized separately be-

fore assembly.

No tapping or "cleaning up" of threads after galvanizing will be permitted. All galvanized nuts shall have a free running fit.

907.03 SHEETS LESS THAN 1/8-INCH THICK.--Steel Sheets less than 1/8 inch in thickness, required to be galvanized, unless otherwise specified, shall be hot-dip galvanized in accordance with the applicable requirements set forth in Sections 907.01 and 907.02; however, the sheets may be galvanized either before or after fabrication and the total of the weights of the 2 galvanizing coatings, one on each side of any sheet, shall not be less than 2.0 ounces per square foot, and such galvanizing shall be in accordance with the requirements of ASTM "Standard Specifications for Zinc-Coated (Galvanized) Iron or Steel Sheets, Coils, and Cut Lengths," Designation A 93.

907.04 OTHER STEEL OR IRON PRODUCTS.--The galvanizing of other steel or iron products shall be in accordance with the requirements of the appropriate ASTM Standard Specifications.

907.05 PAYMENT.--Galvanizing shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## Section 908

### Blast Cleaning of Steel

908.01 GENERAL.--Blast cleaning of steel shall be done when specified on the plans or in the Special Provisions, or when it is necessary for preparing surfaces for subsequent painting thereof. Generally speaking, blast cleaning will be required only for existing structures in need of repairs or painting.

Adequate measures shall be taken to protect persons and property while blast cleaning is in progress; for example, when blast cleaning is being performed on structures open to traffic the Contractor shall provide suitable protective devices to prevent damage to such traffic.

When blast cleaning is being performed near machinery, all journals, bearings, motors, moving parts, etc., shall be sealed against entry of dust, sand, grit, shot, or other abrasive materials, before cleaning begins.

When blast cleaning is specified on the plans or in the Special Provisions as a prerequisite to painting, all blast cleaned surfaces shall be primed the same day blast cleaning is performed; the intent being to make certain that the paint is applied to absolutely rust-free surfaces. In the event that rust should reform on any such surface during the period intervening between the blast cleaning and the painting, such rust shall be completely removed by suitable means before the paint is applied.

All sand, grit, shot, or other abrasives, deposited at, or adjacent to, the work, as a result of the blast cleaning operations, shall be removed from the site by the Contractor, unless otherwise specified.

All preparatory or other solvent cleaning, preparatory hand cleaning or power tool cleaning, and blast cleaning proper shall be done in accordance with the applicable requirements of the "Steel Structures Painting Manual, Volume 2, Systems and Specifications," by the Steel Structures Painting Council, particularly with respect to the material in "Section 2 SSPC Surface Preparation Specifications," of which components Nos. 5 and 6 are reproduced in part hereinafter for the Contractor's convenience, and are considered to be a part of these Standard Specifications. Blast cleaning of steel shall be performed either as blast cleaning to "white" metal, commercial blast cleaning, or brush-off blast cleaning, as required by the plans or Special Provisions, and as hereinafter specified.

908.02 BLAST CLEANING TO "WHITE" METAL. --The Steel Structures Painting Council Surface Preparation Specifications (SSPC - SP5 - 52T, August 28, 1952) are reproduced in part as follows:

"NO. 5 BLAST CLEANING TO 'WHITE' METAL

"1. Scope

1.1. This specification covers the procedure required for blast cleaning to 'white' metal of structural steel surfaces prior to painting.

"2. Definition

2.1 Blast Cleaning to 'White' Metal is a method of preparing metal surfaces for painting by removing all mill scale, rust, rust-scale, paint, or foreign matter by the use of abrasives propelled through nozzels or by centrifugal wheels.

2.2 'White' Metal is defined to mean a surface with a gray white, uniform metallic color, slightly roughened to form a suitable anchor pattern for coatings. The surface when viewed without magnification shall be found free of visible mill scale, rust, corrosion, oxides, paint or other foreign matter.

"3. Procedures

3.1 Blast Cleaning to 'White' Metal shall consist of the following sequence of operations:

3.1.1 Heavy deposits of oil or grease shall be removed by the methods outlined in Specification SSPC-SP 1-52T, 'Solvent Cleaning,' Small quantities of oil or grease may be removed by the blast cleaning operation. If oil and grease are removed by blast cleaning, the abrasive shall not be reused if such reuse is detrimental to the surface.

3.1.2 Excessive rust-scale shall, preferably, be removed by impact tools, as outlined in Specification SSPC-SP 2-52T, 'Hand Cleaning,' or Specification SSPC-SP 3-52T, 'Power Tool Cleaning.'

3.1.3 All visible mill scale, rust, paint, and foreign matter shall be completely removed from the surface of the metal by any of the follow-

ing methods:

3.1.3.1 Dry sandblasting using compressed air blast nozzles and dry sand of a maximum particle size no larger than that passing through a 16 mesh screen, U.S. sieve series.

3.1.3.2 Wet or water-vapor sandblasting using compressed air blast nozzles, water and sand of a maximum particle size no larger than that passing through a 16 mesh screen, U.S. sieve series.

3.1.3.3 Grit blasting using compressed air blast nozzles and crushed grit made of cast iron, malleable iron, steel, or synthetic grits other than sand, of a maximum particle size no larger than that passing through a 16 mesh screen, U.S. sieve series. The largest commercial grade of metal grit permitted by this specification is SAE No. G-25 abrasive material.

3.1.3.4 Shot blasting using compressed air nozzles and cast iron, malleable iron, steel, or synthetic shot of a maximum size no larger than that passing through a 16 mesh screen, U.S. sieve series. The largest commercial grade permitted by this specification is SAE No. S-330.

3.1.3.5 Closed, recirculating nozzle blasting using compressed air, vacuum, and any of the preceding abrasives.

3.1.3.6 Grit blasting using centrifugal wheels and crushed grit made of cast iron, malleable iron, steel, or synthetic grits of a maximum particle size no larger than that passing through a 16 mesh screen, U.S. sieve series. The largest commercial grade of metal grit permitted by this specification is SAE No. G-25.

3.1.3.7 Shot blasing using centrifugal wheels and cast iron, malleable iron, high carbon steel, or synthetic shot of a maximum particle size no larger than that passing through a 16 mesh screen, U.S. sieve series. The largest commercial grade permitted by this specification is SAE No. S-330.

3.2 The surface, if dry blasted, shall be brushed with clean brushes made of hair, bristle or fiber, blown off with compressed air (from which detrimental oil and water have been removed), or cleaned by vacuum, for the purpose of removing any traces of blast products from the surface, and also for the removal of abrasive from pockets and corners.

3.3 The surface, if wet sandblasted, shall be cleaned by rinsing with fresh water to which sufficient corrosion inhibitor has been added to prevent rusting, or with fresh water followed by an inhibitive treatment. This cleaning shall be supplemented by brushing, if necessary, to remove any residue.

3.4 The compressed air used for nozzle blasting shall be free of detrimental amounts of condensed water or oil. Adequate separators and traps shall be provided.

3.5 Blast cleaning operations shall be done in such a manner that no damage is done to partially or entirely completed portions of the work.

3.6 Dry blast cleaning operations shall not be conducted on surfaces that will be wet after blasting and before painting, or when the surfaces are less than 50°F. above the dew point, or when the relative humidity of the air is greater than 85 per cent, unless a water-tolerating inhib-

"itive treatment or coating will be applied before rusting occurs.

3.7 The blast cleaned surface shall be examined for any traces of oil, grease, or smudges. If present, they shall be removed as outlined in Specification SSPC-SP 1-52T, 'Solvent Cleaning'.

3.8 The height of profile of the anchor pattern produced on the surface shall be limited to a maximum height that will not be detrimental to the life of the paint film. The maximum particle sizes specified in paragraphs 3.1.3.1 to 3.1.3.7 may produce an anchor pattern that is too high or too rough for the paint system to be used. In such cases the abrasive sizes should be reduced. If the application of the second coat of paint is deferred, an adequate reduction in anchor pattern height shall be made.

3.9 The height of the anchor pattern can be determined by grinding a flat spot on the blasted surface until the bottoms of the pits are almost reached. The height may then be measured with a micrometer depth gauge graduated to read 0.001" and with a base having a bearing length of two inches and a measuring rod of 3/32" diameter.

3.10 The blast cleaned surface shall be further treated or primed, as specified in the agreement covering the work, within 8 hours after blasting when practical, but in any event not later than 24 hours after blasting and also before any visible or detrimental rusting occurs.

#### "4. Safety Precautions

4.1 If fire or explosion hazards are present, proper precautions shall be taken before any work is done. If the structure previously contained flammable materials, it should be purged of dangerous concentrations.

4.2 Nozzle blast operators exposed to blast dust shall wear a U.S. Bureau of Mines approved helmet connected to a source of clean, compressed air.

4.3 Filter-type air respirators should be worn by all others who are exposed to blast dust environment. Adequate protection for personnel from flying particles shall also be provided in any blasting operation.

4.4 Safety Goggles shall be worn by all persons near any blasting operation.

4.5 Blast hose shall be grounded to dissipate static charges."

908.03 COMMERCIAL BLAST CLEANING. --The Steel Structures Painting Council Surface Preparation Specifications (SSPC-SP6-52T, August 28, 1952) are reproduced in part as follows:

#### "No. 6 COMMERCIAL BLAST CLEANING

##### "1. Scope

1.1 This specification covers the procedure required for the commercial blast cleaning of structural steel surfaces prior to painting.

##### "2. Definition

2.1 Commercial Blast Cleaning is a method of preparing metal surfaces for painting by removing all mill scale, rust, rust-scale, paint,"

"or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels, to the degree hereafter specified.

### "3. Procedures

3.1 Commercial Blast Cleaning shall consist of the following sequence of operations:

3.1.1 Same as 3.1.1 of "No. 5 Blast Cleaning to 'White' Metal".

3.1.2 Same as 3.1.2 of "No. 5 Blast Cleaning to 'White' Metal".

3.1.3 The surface of the metal shall be commercially blast cleaned by any of the following methods. A commercially blast cleaned surface is defined as one which is cleaned at least as well as one air pressure blasted with dry Ottawa silica sand, American Foundryman's Association standard grade No. 27, through a new nozzle, with a one-quarter inch diameter bore, using an air pressure of 90 pounds per square inch gauge at the entrance to the nozzle. During this test the nozzle shall be held at the optimum angle and distance for the particular surface being cleaned. In this test a plane or slightly curved surface shall be cleaned at a rate of three square feet per minute of blasting time. This test establishes a standard for surface preparation and shall not be considered as a production rate of cleaning."

3.1.3.1 thru 3.1.3.7, incl. --Same as 3.1.3.1 thru 3.1.3.7, incl., of "No. 5 Blast Cleaning to 'White' Metal."

3.2 thru 3.10, incl. - Same as 3.2 thru 3.10, incl., of "No. 5 Blast Cleaning to 'White' Metal."

4. and 4.1 thru 4.5, incl. --Same as 4. and 4.1 thru 4.5, incl., of "No. 5 Blast Cleaning to 'White' Metal".

908.04 BRUSH-OFF BLAST CLEANING. --Brush-off blast cleaning, when specified on the plans or in the Special Provisions, shall be in accordance with the Steel Structures Painting Council Surface Preparation Specifications, "No. 7 Brush-Off Blast Cleaning," (SSPC-SP7-52T, August 28, 1952).

908.05 PAYMENT. --Blast cleaning of steel shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

## **Section 909**

### **Painting**

909.01 GENERAL. --Painting shall include proper preparing of the surfaces to be painted, furnishing, mixing, and applying the painting materials, drying and protecting the paint coatings, and furnishing, maintaining and removing scaffolding and other equipment and appurtenances required for the work, together with all proper facilities for the storing and moving of materials, equipment and appurtenances and the protection of the public and the work from damage and nuisance resulting from the painting operations. Painting shall be carefully, neatly and expertly done in accordance with the best practices of the trade by skilled and competent painters who are thoroughly familiar with the type of work they are performing.

The Contractor shall notify the Engineer forty-eight (48) hours prior to the time he intends to commence painting and also shall notify the

Engineer immediately after each coat has been completed. All work and materials will be subject to continuous inspection during the progress of the work, and upon completion.

Unsatisfactory work, and defects, caused by improper conditioning of surfaces for painting, faulty materials or workmanship, or completed painted surfaces not in accordance with the specifications, shall be satisfactorily corrected by the Contractor at his sole expense, to the extent required by the Engineer, including removal of unsatisfactory paint coatings and subsequent repainting.

The Contractor shall furnish, maintain, and remove as his property upon completion of the work, all scaffolding, planking and other equipment and appurtenances which he may require for the proper execution and completion of the work.

The Contractor shall set aside a shed, room or other satisfactory space in which to store and mix materials and shall provide suitable vessels in which all paint mixing shall be done. The Contractor shall not allow discarded paint materials, cans, oily rags, waste, and combustible or flammable materials to accumulate, but shall remove them from the work each night, and shall exercise all other reasonable precautions to prevent fire.

In areas where painting is in progress, the Contractor shall provide and properly locate sufficient drop cloths to protect the work and other property from paint splashes or damage. Special care shall be taken to protect hardware, light fixtures, glassware, finished brickwork, finished floor and wall surfaces, sidewalks, and parked automobiles. Where painting is in progress in buildings being utilized, particular attention shall be paid to office machines, equipment, desks, chairs, and the like, which shall be adequately protected by drop cloths. The Contractor shall place such drop cloths at the start of each of his work periods and when required shall remove them at the conclusion of each such work period.

The color of each coat of primer and paint shall be as specified, or as designated by the Engineer, and samples of the colors and shades to be used shall be submitted by the Contractor, for selection and approval by the Engineer, sufficiently in advance to cause no delay in the work.

If the paint the Contractor proposes to use is not the usually used product and factory color for the application involved and exactly as specified, he shall not commence painting any surface therewith prior to approval by the Engineer of actual samples of each color and shade prepared by the Contractor from the paint intended for use in the work. The samples shall be of adequate size to allow the Engineer to reasonably pass judgment on color, shade, texture and gloss. All paint shall be factory mixed to its final color whenever practicable.

When equipment to be painted by the manufacturer is not manufactured locally, the Contractor shall secure and submit to the Engineer the equipment manufacturer's certification that the preparation of surfaces and application of the prime coats have been made in accordance with the recommendations of the paint manufacturer.

No prime coat will be required on work which has been shop coated

or previously painted, except that damaged areas of such primer or paint shall be suitably touched up with primer, to the satisfaction of the Engineer, before application of a subsequent coat of paint.

The metal surfaces of pipe to be insulated shall not be primed or finish painted unless otherwise specified.

Other metalwork not to be painted unless specified, shall be that metal embedded in concrete, piping buried in the ground, brass, bronze, other non-ferrous metals, stainless steel, and certain equipment and parts thereof designated by the Engineer.

Paint shall be applied only on thoroughly dry surfaces during periods of favorable weather, and unless otherwise specified, in accordance with the manufacturer's recommendations. Painting will not be permitted in rainy, damp, misty, or frosty weather; when freshly painted surfaces may become damaged by rain, fog, condensation, or frost; or when, in the opinion of the Engineer, conditions are otherwise unsatisfactory. The temperature shall be that which will not materially alter the characteristics of the paint.

Where necessary, the Contractor shall take adequate steps to eliminate dust before painting.

#### 909.02 MATERIALS

General.--All painting materials shall be pure, unadulterated, of first quality, of the type expressly designed for the surface and condition for which its use is required, and shall be delivered to the work in original unbroken containers, bearing the manufacturer's name and other information necessary for identification. Materials shall be delivered not less than one (1) week before they are intended to be used, to permit required sampling and testing, and containers shall be opened and materials mixed at the site of the work in the presence of the Engineer. Materials whose containers are not originally opened in the presence of the Engineer, or materials which are not in accordance with the specified requirements, will be rejected and immediately shall be removed from the work by the Contractor.

Specification of materials by manufacturers' trade names and designations is not intended to imply or suggest that products of these manufacturers are preferred or need to be used, but only to designate a standard of quality and type of material required.

If the Contractor elects to furnish substitute paint materials in lieu of those specified, he shall furnish to the Engineer upon request a certificate from the manufacturer that the substitute materials comply with the specifications, accompanied by a certified formula of constituents for each of the substituted materials.

Paints, stains, primers and sealers shall not be thinned by any material not specifically recommended or approved for such purpose by the manufacturer of the paint, stain, primer or sealer, as applicable, and then not in excess of the amounts recommended or approved by such manufacturer.

No primer or sealer shall be used unless that type of primer or sealer is specifically recommended or approved by the manufacturer of the paint or stain which will be applied over the primer or sealer,

as applicable.

Aluminum Paint.--Aluminum paint shall consist of aluminum pigment paste mixed in a vehicle, in the proportion of not less than 2 pounds of paste per gallon of vehicle. The aluminum pigment paste shall comply with ASTM "Standard Specifications for Aluminum Pigments, Powder and Paste, for Paints," Designation D 962.

Linseed Oil.--Raw and boiled linseed oil shall be in accordance with the requirements respectively, of ASTM "Standard Specifications for Raw Linseed Oil," Designation D 234, and "Standard Specifications for Boiled Linseed Oil," Designation D 260.

Turpentine.--Turpentine shall be pure, either gum or steam distilled spirits, in accordance with the requirements of ASTM "Standard Specifications for Spirits of Turpentine," Designation D 13.

Mineral Spirits.--Mineral spirits shall be in accordance with the requirements of ASTM "Standard Specifications for Petroleum Spirits (Mineral Spirits)," Designation D 235.

Driers.--Driers shall be in accordance with the requirements of ASTM "Standard Specifications for Liquid Paint Driers," Designation D 600.

Denatured Alcohol.--Denatured alcohol shall be United States Internal Revenue Formula No. 5.

### 909.03 PREPARATION OF SURFACES

General.--The Contractor shall not commence the painting of any surface until that surface has been satisfactorily prepared by him and subsequently examined and approved for painting by the Engineer. Paint coatings applied to surfaces that have not been approved by the Engineer will be considered unsatisfactory coatings and, as hereinbefore specified, will be subject to removal.

All surfaces to be painted shall be thoroughly cleaned of all rust, corrosion, loose mill scale, welding flux, dirt, dust, mud, oil, grease, wax, old paint that is loose, blistered, cracked or otherwise unsatisfactory, loose surface materials, moisture, acids, alkalies, or other foreign matter.

Metal Surfaces.--Metal surfaces shall be thoroughly cleaned by wire brushing, scraping, chiseling, hammering, blast cleaning, or other approved means, and the surface wiped clean. Exposed metal surfaces coated with dirt and grease only, may be washed with benzine to remove same. No larger area of metal shall be cleaned in advance of painting than can be completely painted before further corrosion, oxidation or dirt accumulation begins. If previously cleaned surfaces are not painted prior to further corrosion, oxidation or dirt accumulation, they shall be recleaned as necessary.

Prime coated surfaces showing signs of rust or other defects, prior to field painting, shall be thoroughly cleaned and reprimed.

Galvanized metal surfaces shall be brushed twenty-four (24) hours in advance of painting with a solution of 4 ounces of copper sulphate to one gallon of water, which shall stand for one (1) hour and then be thoroughly flushed with clean water and wiped off.

Where solder fluids have been used, metallic surfaces shall be

thoroughly cleaned with lacquer thinner before any paint is applied.

Wood Surfaces.--Unless otherwise specified, all wood surfaces, except exterior wood surfaces, shall be sandpapered before any finish is applied, and, where necessary, further sandpapered between coats. All knotholes, pitch pockets or sappy portions shall be sealed with shellac or approved resin sealer under natural finishes, and aluminum paint under paint finishes. Shellac shall not be used on surfaces exposed to the weather. After priming or sealing, all nail holes shall be carefully filled with putty colored to match the finish. All wood to be painted shall be dry before paint is applied.

Plaster Surfaces.--All plaster surfaces shall be properly sized and sealed as necessary to prevent stains and burns, overcome excessive suction, seal air checks and fine cracks and otherwise provide a suitable surface. Sizing shall be such that no peeling, flaking, or popping will result from the use thereof. The sealer shall be capable of bridging air checks and fine cracks.

Concrete Surfaces.--All concrete surfaces shall be wire brushed, blast cleaned or power sanded to remove all traces of form oil and glaze, after which they shall be treated with a solution of 3 pounds of zinc sulphate to one gallon of warm water. The solution shall be brushed on warm and allowed to dry thoroughly, or for not less than twenty-four (24) hours, after which the surface shall be thoroughly flushed with clean water or wiped with damp burlap and allowed to dry, then further prepared by the application of an approved sealer-primer.

909.04 APPLICATION.--All paint and related products not obtainable factory mixed shall be mixed, thinned if required for proper workability, and applied in strict accordance with the recommendations of the manufacturer.

Priming and painting shall be commenced immediately after the surfaces have been approved therefor, except that it shall be the responsibility of the Contractor not to commence work or to halt work, if weather or other conditions that will affect the work become unfavorable.

Care shall be exercised to maintain surfaces in the specified condition until the paint is applied; adequate provision shall be made to protect and maintain the newly painted work.

Prior to application, paint shall be mixed a sufficient length of time to thoroughly mix the pigment and vehicle together and during application, paint shall be kept thoroughly mixed to keep the pigments in suspension. Paint shall be stored on the job in sealed containers.

All paint shall be applied at the proper viscosity. In cool weather, paint shall be heated to reduce its viscosity and facilitate its use. Such heating shall be accomplished by immersing the paint containers in hot water, or heating by other approved means.

Paint materials shall be applied, either by brush or spray, in uniform coats free of runs, sags, thin areas, skips or holidays.

Paint brushes shall be of the best quality, of the proper size, and shall have sufficient body and length of bristle to spread the paint in a uniform coat. In general, the primary movement of the brush shall

describe a series of small circles, to fill all irregularities in the surface, after which the coating shall be smoothed by a series of parallel strokes. Paint shall be evenly spread and thoroughly brushed out. If a considerable amount of brush marks appear, it will be considered that the paint has been improperly applied. For painting structural steel, round or oval brushes, or approved flat brushes not over 4 inches in width, shall be used. On all surfaces which are inaccessible for painting by regular means, the paint shall be applied by sheepskin daubers, bottle brushes, or by any other means necessary to obtain the proper thickness of paint.

Power spray equipment, if used, shall be modern, in good order, shall include approved water traps, and shall apply the paint in a fine, even spray. When spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat, or skips and holidays shall be considered as evidence that the work is unsatisfactory and the Contractor may be required to apply the remainder of the paint by brush. In any event, uniform coverage, free of wrinkles, blisters or airholes shall be obtained with each coat of paint.

When more than one coat of paint is specified, each undercoat shall be a near match in color to the finish coat, but enough difference in color shall exist to distinguish between separate coats. Each coat of paint shall be slightly darker than the preceding coat, unless otherwise directed by the Engineer. The final coat shall be of the color selected by the Engineer from samples as hereinbefore specified.

The first field coat on metalwork shall be applied immediately after installation. The last field coat shall be applied after final cleaning up of the work and final testing of equipment.

The paint for each coat shall be both mixed and applied so that the painting will be smooth, uniform, and spread so that no excess paint will collect at any point.

The thickness of each coat shall not exceed that which will result in uniform drying throughout the paint film. In certain critical cases, the thickness of each coat will be specified on the plans or in the Special Provisions.

No intermediate or final coat of paint shall be applied until the preceding coat is dry and hard, except in the case of exterior cement-type paint. Time allowed for drying shall in all cases be ample to secure the best possible results.

Sufficient paint shall be applied, in successive coats, to provide a satisfactory cover when the work is completed, but the quantity used for any individual coat or portion thereof shall not be excessive or such as to result in a thicker application than will properly set within a reasonable period, forming a hard, firm and uniformly smooth coating free of blisters, flat spots and similar defects.

The finish work shall show no cloudiness, spotting, holidays, laps, brush marks, runs, curtains, sags, ropiness, or other surface defects not consistent with first class workmanship.

Identification and rating plates of equipment shall be painted with three (3) coats of clear varnish only.

909.05 FINAL CLEANUP. --The Contractor shall remove all dropped and splattered paint and other stains and blemishes resulting from his operations. If such stains or blemishes cannot be satisfactorily removed from surfaces painted by him, or from existing finished surfaces, such surfaces shall be satisfactorily repainted or otherwise refinished by him at his expense in such manner that all stains and blemishes will be obliterated and the finished surface will be as specified, or in the case of existing surfaces, shall match satisfactorily the adjacent surfaces in color and texture.

909.06 DETERIORATION OF PAINTED SURFACES. --Painted surfaces that, within one year after painting, are found to be non-uniform in color or texture or show evidence of excessive deterioration such as cracking, crazing, blistering, running, peeling, scaling, checking, alligatoring, streaking or staining, will be considered the result of faulty materials or workmanship and shall be satisfactorily refinished by the Contractor in accordance with the requirements of Section 105.10. All painted surfaces shall be capable of withstanding the chemical and physical action of washing with alkali-free soap and water to remove surface dirt without causing the aforementioned deterioration.

909.07 PAYMENT. --Painting shall be done as Incidental Work and payment therefor shall be included in the price or prices bid.

Section 910

Riprap

910.01 GENERAL. --The Contractor shall furnish and place riprap to the lines, grades and depths shown on the plans, or where specifically ordered by the Engineer.

910.02 ROCK. --Rock for riprap shall be hard, durable and not subject to disintegration by the action of air or water. When tested for soundness by the sodium sulphate test in accordance with the requirements of ASTM "Standard Method of Test for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate", Designation C 88, not more than 7 percent of the rocks tested after 5 cycles of immersion and drying shall show any of the following types of deterioration: (1) Disintegration; (2) Splitting; (3) Crumbling; (4) Cracking; (5) Flaking. Sound metamorphic sandstone and basalt will pass this test; shale, weathered sandstone and igneous rock subject to splitting in seams will not pass the test.

Percentage by weight of the various individual rock weights shall be as follows:

<u>Percent of Total Weight</u>	<u>Approximate Limits of Rock Weights</u>
40 percent .....	400 lbs. to 200 lbs.
35 percent .....	200 lbs. to 50 lbs.
25 percent .....	50 lbs. to 2 lbs.

No stone shall be less than 2 inches in diameter.

When required by the Engineer, samples of the rock shall be furnished by the Contractor and tested by the City at no cost to the Contractor.

910.03 PLACING. --Rock shall be well graded and placed to form a practicable minimum of voids. In general, the larger rocks shall be dumped first and the smaller rocks shall be dumped and distributed to fill the voids.

910.04 PAYMENT. --Riprap, satisfactorily furnished and placed as specified, will be paid for at the price bid per ton.

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